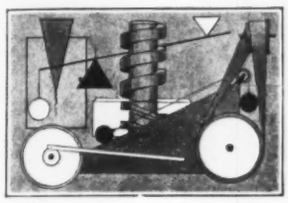
MACHINE DESIGN

as it affects

ENGINEERING–PRODUCTION–SALES

Volume 4 | February, 1932 | Number 2



Forthcoming ISSUES

THOUGH much has been said on the application of hydraulics to machinery—MACHINE DESIGN *published a series on the subject two years ago and numerous discussions have appeared since that time—the subject still is far from being exhausted.*

Further articles on the hydraulic art are planned which it is anticipated will prove extremely valuable to designers of machinery, particularly since this method of actuating machine parts and mechanisms is becoming increasingly popular. The first section of the series commences on page 35.

L. E. Jermy

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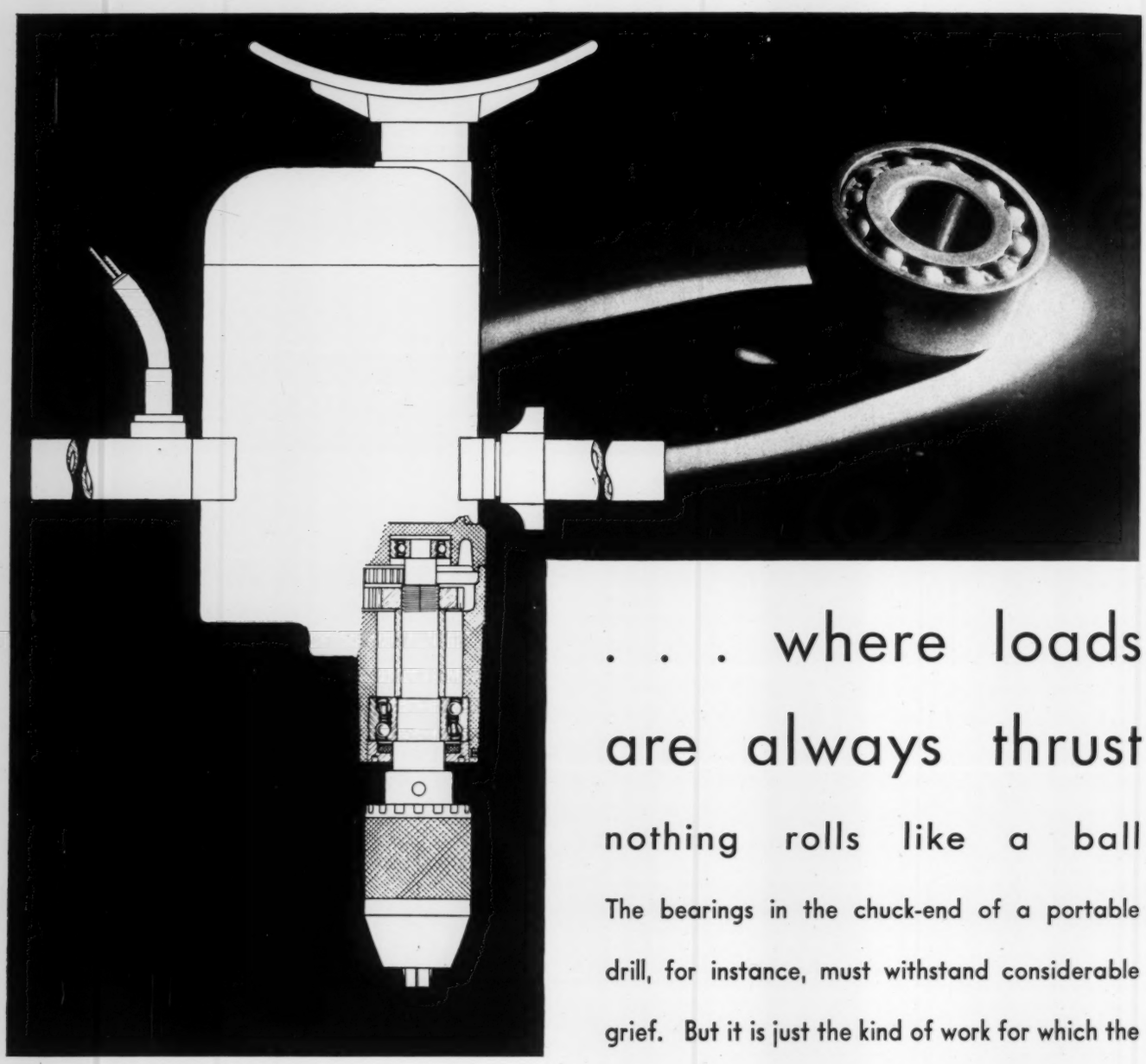

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New Departure

Ball Bearings

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Key: Edit, Editorial Pages; Adv Advertising Pages; R, Right hand column; L, Left hand column

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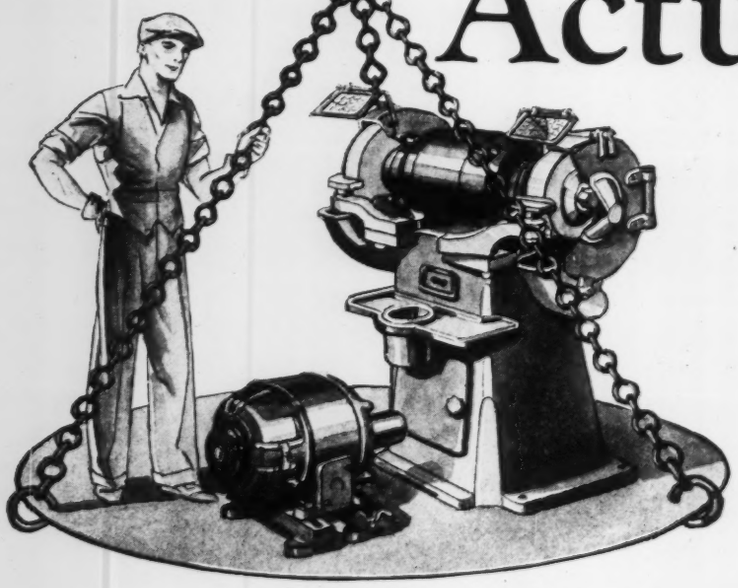
The Actual Cost



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MACHINE DESIGN

THE JOHNSON PUBLISHING COMPANY, CLEVELAND, OHIO

February, 1932 Vol. 4—No. 2

Design and Purchasing Should Go Hand-in-Hand

By L. E. Jermy

Managing Editor, Machine Design

A STUDY of the relations between design engineers and purchasing agents is certain to lead to the conclusion that the only important obstacle to harmony lies in the conflicting temperaments which are more or less inherent in the two professions. These diametrically opposed personal characteristics are reflected in the comments by purchasing agents and engineers published in this and last month's issues of MACHINE DESIGN.

Engineers—charged with and willingly assuming full responsibility for the machines they design—naturally are inclined to be careful, conservative and suspicious. The majority of engineers admit freely that these characteristics are typical of their profession. In fact these qualities are essential to successful design. Unfortunately, however, the average purchasing agent—failing to understand the viewpoint of the designer—places a faulty interpretation on these characteristics. In the eyes of the purchasing official the quality of conservatism in an engineer easily is distorted to one of "old fogyism"; that of staunchly defending quality against price becomes "obstinacy"; and that of adhering to sound engineering principles is looked upon as an evidence of a "high-hat" attitude.

On the other hand, purchasing agents—charged by management with the responsibility of procuring supplies, parts and materials at the most advantageous terms—have developed a technique which calls for qualities not fully understood by the average engineer engaged in design. We believe the majority of engineers, including many of those who have a good conception of the commercial side of the machinery manufacturing business, possess an inherent aversion to the details of barter and trade. This statement is made advisedly,

IN last month's issue some of the views purchasing agents hold of engineers were given in a composite letter which included comments from a number of men in the purchasing field. The purchasing agents found much to criticize in the apparent attitude of aloofness and the conservatism of many engineers responsible for design.

This month the engineers' replies are presented. Their comments, considered with those of the purchasing agents, undoubtedly will go far toward disclosing the reasons for misunderstanding that exists between the two departments, and in effecting closer relationship.

—The Editors

but with the strong conviction that it is an important factor in the difficulty encountered by many engineers in trying to understand the tactics of purchasing agents. There is no doubt that many of the characteristics which are essential to successful purchasing are badly misinterpreted by many designers. Often the sincere efforts of the purchasing department to find an adequate material at better terms are viewed by the design department as undue activity to "cheapen" the machine.

This tendency to exaggerate the other side's shortcomings is of course unfortunate. But in reality it is no worse than similar situations existing in many fields of human activity. Consider for instance the relations between high army and navy officers and civilians. The former, belonging to the military profession, hold to certain tenets which are always misunderstood by the average layman. Industrial executives and bankers find it difficult to understand each other—they, too, approach problems from entirely different angles. One could name numerous other relationships in which the individual whose work involves special or professional ability is misunderstood by others.

In recent years there has been a noticeable movement toward eradicating the source of misunderstanding. Navy officers—referred to in the previous paragraph—rely on the Navy League to disseminate information regarding navy matters for the purpose of affording the public a background of data which will help the layman to understand navy policies. Bankers' organizations are trying to educate the nation to understand the functions of a banker.

What the Engineer Thinks About the P

AFTER reading the comments by purchasing agents in January's issue, one gets the impression that most of their criticism goes back to the alleged cold, analytical, uncompromising attitude assumed by design engineers in selecting parts and materials. We who design machinery are condemned for being too dictatorial, too arbitrary, too blind to the matter of price and too unmindful of the business advantages which come from playing competitive supplies of parts or materials against each other.

While not admitting that all of us are guilty of this blanket indictment, we will answer it with the general statement that the group of purchasing agents—and in fact many of our critics in other groups—seem to lose sight of the important factor of responsibility.

When something goes wrong in the design of a machine, who is held responsible? One of our number, who has had many years of experience in design with representative companies—large and small—comments that he never has seen a purchasing agent put his initial or name on a drawing. When the matter of responsibility arises, the O. K. or approval usually is up to engineer. The engineer is entirely responsible for the functioning of the machines he designs. In assuming this responsibility, is it not natural that he should take his work seriously? Why should he not be careful and conservative and why should he jump at suggestions offered by the purchasing agent or anyone else without first having had time to consider them carefully?

"Many purchasing agents are officious, have a domineering nature and take themselves too seriously!"

Many design engineers can recall with regret times when against their better judgment they have yielded to the arguments of purchasing agents or others. In one case on a job of 50 machines, one of us permitted himself to be influenced by the purchasing agent and the sales manager to use a purchased article which appealed to him so far as appearance was concerned but was not entirely satisfactory constructively. Fortunately the engineer insisted upon a rock-bound guarantee from the manufacturer and when trouble showed up later the blame could not be placed entirely at the feet of the engineer. But in the majority of cases trouble goes back to the designer, and for that reason certain allowances should be made for him if he seems to be unduly concerned in being sure everything is right.

One of us once worked in a large manufacturing plant where a certain head of an engineering design section was the most disliked man in the place, if one judged by the remarks of the members of the sales, production, purchasing and shipping departments. This particular engineer insisted that a machine be right before it was shipped, even though it required rebuilding, with a corresponding delay in shipment, increase in expense, etc. He always was in hot water. However, after a period of time, customers learned that machines from his department could be depended upon and sales increased rapidly. To make the story short, this engineer now holds the position of general manager and as the number of employes exceeds 50,000, it should be sufficient evidence that the board of directors agreed with his policy of "being right." Critics of engineering are justified in counseling against too much emphasis on "pure engineering," but it is well to remember that there can be no substitute for sound design.

The group of purchasing agents emphasized the "high-

Public utility companies spend large sums in trying to show the public how essential is the service of these companies. Much of the activity of the National Association of Purchasing Agents—the official organization of one of the groups under discussion in this article—is devoted to making industry more conscious of the service rendered by professional purchasers.

Many of the engineering societies have tried to give the layman a better understanding of engineering, but we fear that progress in this direction has not been as rapid as could be desired. One reason is that many of the societies still are dominated by engineers of the old school. In their conservatism they are reluctant to strike out boldly in defining to the world at large the true functions of engineering. The public still pictures the product of an engineering school as a serious minded, fussy manipulator of a slide rule. Until that impression is thoroughly squelched, engineers are going to find it extremely difficult to make themselves understood, not only by the casual man on the street, but by members of the great industrial family—including purchasing agents.

Without condoning for a minute numerous obvious shortcomings of many purchasing agents, we contend that the greatest step that can be taken in improving the relations of design engineers with those with whom they deal lies in a complete annihilation of the foolish traditional conception of engineers which has been permitted to take root and spread throughout the United States. The engineer is honored in England, France, Germany; in fact all Europe. Why is he less respected in America?

Purchasing Agent—By a Group of Designers

hat" attitude of engineers, especially their wont to place themselves upon a pedestal—superior to others. Is it not true that many of the more prominent purchasing agents are officious, have a domineering nature and take themselves pretty seriously? Many of them have little technical knowledge and in their dealings with the engineering department they depend on their superior attitude to sustain their objections. In the case of some of them, their policy is to protect themselves always and when mistakes are made to lay the blame at the door of the engineering department.

Here is an illustration of what certain design chiefs are obliged to combat. We quote the story in the chief engineer's own words:

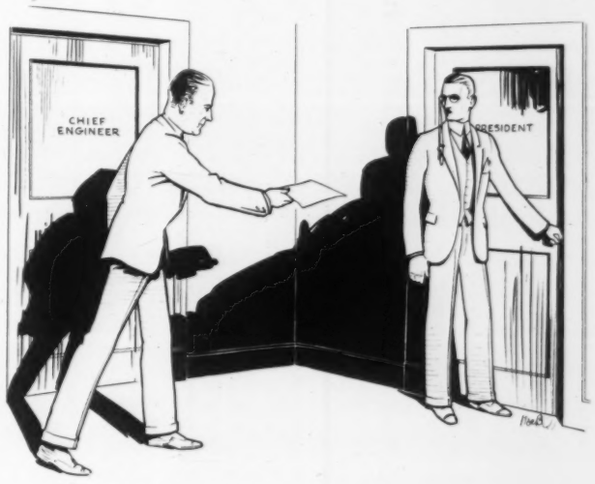
"I have two complaints to make of our purchasing agent. Probably much of the difficulty lies in the fact he is a big stockholder in the company, which gives him a strong backing by the chief executive and a confidence in his own position that he might not have otherwise.

"The first is his continual insistence on buying 'something cheaper.' He keeps a personal record of his purchases and every now and then he shows the big chief how much money he has saved the company by his superior judgment.

"The second is his profound egotism. He has an ironclad rule that no salesman can see any engineer without his express permission. The rule is not objectionable (I fully approve it) but in many cases salesmen who have something in which I would be deeply interested never get beyond the purchasing department because they have something to offer which might cost us more money and in his judgment is not justified. In cases where I ask a salesman to call on me I am obliged to defend my position and explain why I am considering that product.

"I tried once to organize a monthly get-together meeting with the purchasing agent, sales manager, chief executive and myself, where we could all air our views. I got them all together once, but the purchasing agent dominated the meeting and the chief backed him up, so I gave it up as a bad job."

We realize, of course, that this condition is one reflecting on the quality of management. Nevertheless it indicates how a dominating character in the purchasing department can nullify the effect of good engineering in the design department. The point is especially important now, because the depression has accentuated the importance of price until there is danger that it will be given undue weight when balanced against the needs of sound engineering.



"Runs to the boss to get credit for the find and consequently forces hand of engineer"

Some purchasing agents can be criticized on their methods. If by accident or intent they find a new material that has some possibilities from a standpoint of supply or price, they run first to the boss, so as to get the credit for the find before taking it up with the engineer. The boss may authorize the change and if he does so this results in a more or less forced procedure as far as the engineer is concerned. At any rate, this common tendency among purchasing agents to play for executive favor makes it difficult for engineers to co-operate with purchasing departments effectively.

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

Engineers Conquer the Weather

WEATHER to order . . . made possible by the untiring engineer whose ingenuity has created the design of a unit which will heat and humidify the atmosphere of the home or office in winter and cool it in summer!

One of the highest achievements in this connection lies in the potential development of a unit, the working parts of which are centralized preferably in the basement, and are capable of being kept in operation winter and summer. With the trend definitely in this direction, it is noteworthy that Carrier Engineering Corp., Newark, N. J., has equipment under development to fill these requirements. Its present machine, however, is confined to heating, humidifying, cleaning and circulating the air, Fig. 1.

By following the arrows in this illustration the cycle of operation of the Carrier Weathermaker can be traced. Return air is drawn from rooms above the unit through a duct connected to the heater above the chamber marked A. Air passes through filters B, enters blower C, is circulated around heat interchanger D, and next passes over vaporizer E. It then is discharged into ducts taken off from the top of the unit above the interchanger and distributed to the rooms. Gas burners at F supply heat to the interchanger sections, which transmit it to the air. Hot gases, shown by black arrows, pass inside of the interchanger sections and are exhausted through a breaching G, which is connected to the chimney.

A refrigerating unit is expected to be added to the Weathermaker to facilitate its operation the year around. Several other companies have developed units which supplant the radiator in the home and are equipped with coils for steam in winter and refrigerant in summer. The field is yet new and offers tremendous opportunities for engineers interested in this type of development.

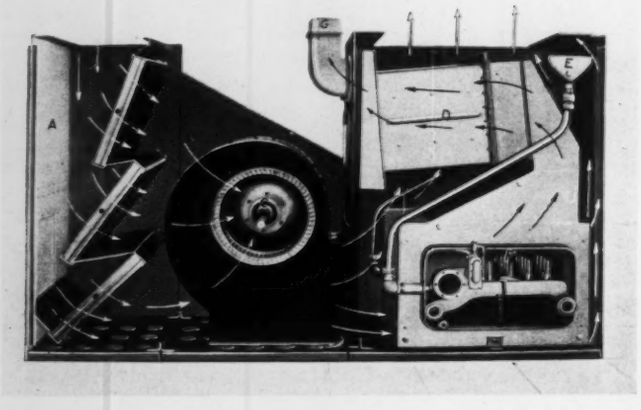
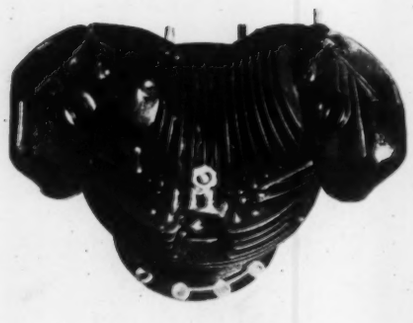


Fig. 1—(Above)—One type of air conditioning machine adaptable to the home. This now is confined to winter use but is about to be augmented by a cooling attachment to make it suitable for year-around operation

Has the Carburetor Had Its Day?

WILL future gasoline engine design forego the necessity of a carburetor? There is strength in the affirmative if the recent development of a new type injection system for the Pratt & Whitney Hornet engine is to be taken as a basis for the answer. Utilizing the principle of atomization and injection of gasoline direct to the cylinder chamber, an engine incorporating this revolutionary system recently carried an airplane successfully through dynamometer and test flights.

Details of design include fuel injection pumps



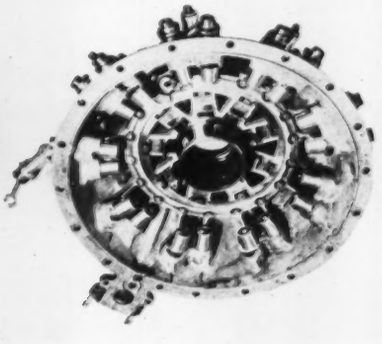


Fig. 2—(Right)—Cylinder and nose section of engine which embodies the principle of atomization and injection of gasoline direct to the cylinder chamber, eliminating carburetor

contained in a special crankcase casting, which replaces the standard front section. The pumps are arranged radially, just forward of the usual valve tappets. Actuating mechanism, Fig. 2 extreme right, consists of a four-lobe cam which is carried on the forward face of the cylinder valve operating cam. This entire assembly is mounted on an extension of the crankshaft thrust bearing retainer. Fuel injection hammers are carried in special guides in the crankcase front section. Injection nozzles, Fig. 2 right, are located in front of the cylinder heads immediately above the spark plugs.

In operation the fuel pump hammers which are provided with shoes, engage the four lobes of the pump operating cam. These cams draw the hammers inward toward the axis of the crankshaft, being arranged so that the hammers are drawn back slowly in order to permit the flow of fuel into the pump cylinders at a normal slow rate. Their contour is such that they overrun a sharp edge on the shoe, allowing the springs which have been compressed by the inward movement of the hammers to return the hammers with a rapid movement, assisting in the fine atomization of the fuel.

Because the entire air induction system, from the air valve through the supercharger and inlet pipes to the cylinders does not contain any combustible mixture, fires resulting from backfire are avoided.

Vacuum Principle Is Utilized

LATENT energy in the form of vacuum in the intake manifold is not being wasted by the designers of present day automobiles. They, like designers of other equipment, are coming to realize, more and more, the advantages of this type of power to simplify controls or actuate mechanisms. Several months ago a vacuum-operated clutch was introduced, (MACHINE DESIGN, December). Now in addition another manufacturer, the Auburn Automobile Co., announces a dual ratio mechanism, also vacuum operated, to give the driver the benefit of a two-speed axle.

Going into the design of the mechanism, Fig. 3, the bevel ring gear instead of being secured to the differential unit, floats on it by means of a two-piece shell, and within the left member is located a planetary gear system that furnishes an overdrive. The center or sun gear is clutched to a stationary collar. Planet gears rotate around the sun gear since their studs are fixed to the shell unit on which the bevel ring gear is mounted. This results in rotation of the internal gear that meshes with the planet gear at a speed in excess of the bevel ring gear.

Since the internal gear is attached to the differential unit, the axle shafts rotate at an increased speed over the bevel gear ratio. The latter ratio prevails when the sun gear is clutched to the shell unit, thereby locking the planetary system so that no rotation of any of its gears can occur. Shifting of the controlling clutch is done by a double-action piston in an air cylinder. A valve controlled by a lever on the dash connects either side of the cylinder to the vacuum in the intake manifold. Flexible connections to the axle are in the form of rubber

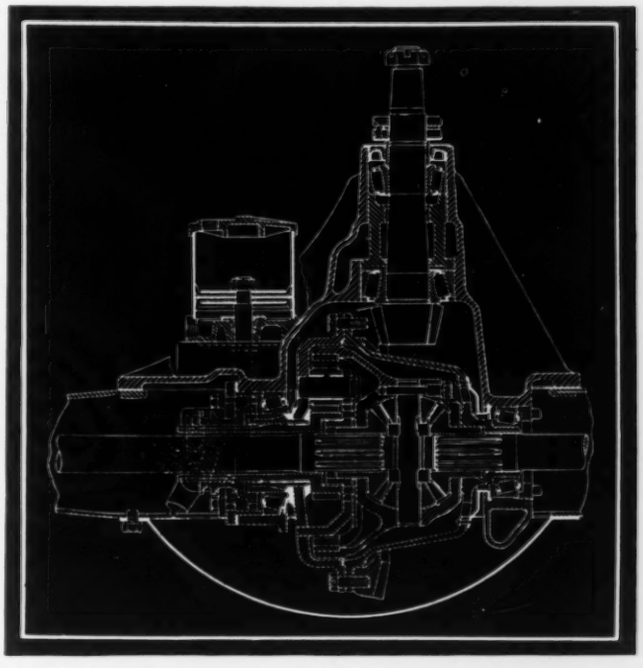


Fig. 3—Dual ratio gearing with which a vacuum-operated cylinder is employed to effect the change in speed

suction hose. In the line between the aforementioned valve and the engine manifold is another valve, interlocked with the free-wheeling control. This is provided so that shifting can be done only while the car is free wheeling.

Metal Processes Show Progress

EVOLUTIONARY changes are taking place in processes of forming metals and more and more the machine is assuming an important role in this development. Recently gray iron was die cast successfully by an experimental machine, and die casting of brass bids fair to become common practice.

Two pressure brass die casting machines have been purchased and placed in the Ansonia, Conn., plant the American Brass Co. These units were designed by Charles Pack, consulting engineer, New York. Doehler Die Casting Co., Batavia, N. Y., has installed six casting machines of the pressure type, designed by the company's own engineers, and Titan Metal Mfg. Co., Bellefonte, Pa., has placed in operation three brass die casting machines of the pressure type, perfected by Josef Polak, Prague, Czechoslovakia. Mr. Pack

predicts that the phrase "pressure casting" soon will be recognized in the trade as describing the product and process in contrast with the current term "die casting."

Within the last month Nathan Lester, a Cleve-

Fig. 4—Nonferrous parts produced by new metal forming machine utilizing increased pressure to obtain finish

land engineer, introduced a machine which is claimed to differ radically from the conventional type in that the molten alloy is injected into the die by direct action of a pump under a pressure of 1500 pounds per square inch. The increased pressure makes it possible to maintain the working temperature of the metal at a lower point, thereby aiding in securing a better finish of the casting.

Concurrent with these developments in casting molten metals, National Machinery Co., Tiffin, O., has shown progress in a process known as coining or "maxipressing." Machining by pressure, as it also is called is accomplished by a huge press. Finish forging on this machine can be done with the heat remaining from forging or annealing at a temperature below that at which scale is formed. Accurate brass forgings also have been produced successfully with this machine. Samples of work on nonferrous parts are shown in Fig. 4. The machine also has wide application for finish forming of bosses, pads and other surfaces of malleable iron parts.

With the new machines for pressure casting and forming, increased production and economy are possible. It is anticipated, therefore, that alert designers will watch these new developments closely and give increasing consideration to the specification of parts produced by the methods involved.

Streamline for More Efficiency!

STREAMLINING and increased efficiency are synonomous as revealed by tests conducted by Dr. Oskar G. Tietjens, Westinghouse technician. Not only is streamlining indicative of a trend but it also shows that the designer of vehicular units must look beyond the pure mechanics involved in the power plant and other parts of the driving mechanism. These fundamental technical details could reach the acme of refinement, yet the entire machine might be a singular example of inefficiency—all because streamlining has been overlooked.

Locomotives, airplanes, street cars and particularly automobiles, are coming in for their share of streamlining. The Rolls-Royce with special body, Fig. 5, is an outstanding example of what is being done in the automotive industry along this line. As Dr. Tietjens says, if the body, wheels and fenders considered as a unit are shaped according to modern aerodynamics, a car shape can be developed that will have but one-fifth the air resistance of the old type of automobile. Streamlining, moreover, does not sacrifice seating capacity. It facilitates the installation of the engine in the rear, a feature of the new car designed by Sir Dennistoun Burney, eminent English engineer.

Figures compiled as a result of tests show that such a car would require only 30 horsepower instead of 90 horsepower for an 80 mile per hour speed; less than 50 horsepower would be required to go 100 miles an hour in contrast with the 160 horsepower needed when streamlining is absent. The percentage of horsepower saved by streamlining increases with the speed. At 40 miles per hour, 50 per cent is saved; at 70, 65 per cent and at 90, 70 per cent.

One of the fastest electric lines in existence

Fig. 5—Tendency toward the increased use of streamlining is seen in this new model automobile

is the Philadelphia & Western railroad from Philadelphia to Norristown, which has streamlined cars. Engineers say the new cars can do 80 miles an hour with safety. It will be remembered that on the racing car which carried Capt. Malcolm Campbell to victory at Daytona Beach, breaking all land speed records, streamlining was given primary consideration. The trend toward unbroken lines and graceful curves has gathered momentum and its effect is widespread, reaching even to stationary machines in which apearance has been appreciably enhanced.

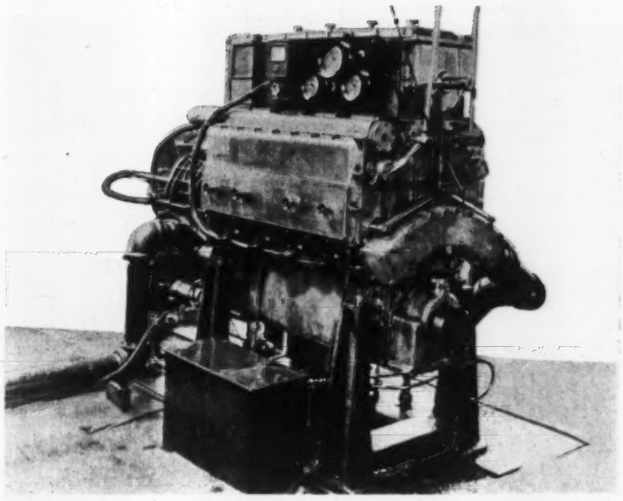


Fig. 1—General view of engine showing ends of upper and lower crankshafts, control handle in front, blower in rear, instrument board, etc.

Simplicity, Compactness Characterize New Two-Stroke Engine

OF OUTSTANDING interest among recent engineering developments is the 8-cylinder internal combustion engine based on diesel principles which has been designed and built by F. B. Stearns, well known pioneer in the automotive industry. As announced in the January issue of MACHINE DESIGN twelve years have been spent in perfecting this engine and bringing it to the point where it may bear a strong influence on the use of the injection engine in the aviation, railroad, automotive, marine and other fields.

The new engine is extremely compact and is built of aluminum alloys with the exception of such parts as the nickel iron cylinder sleeves, chrome nickel crankshafts and fuel camshafts, the connecting rods and the nitrided steel plunger and bushing of the fuel pump.

In order to overcome vibration to the fullest possible extent, the two-stroke principle is employed and the eight cylinders are arranged in diamond fashion with 16 opposed pistons as shown in Fig. 3. The upper and lower crankshafts connected by double helical gearing at the rear of the engine. Smoothness of operation naturally is effected by the use of the two-stroke principle, there being an explosion each time the pistons pass top center rather than on alternate strokes as with the four-cycle.

Two-stroke diesel-type engines have previously been constructed and are in use, but as far as is known this is the first to incorporate cylinders arranged in the shape of a diamond. Considerable advantage is gained from the latter inasmuch as the cylinders are smaller than in the vertically opposed piston type and can be easily scavenged; more even firing also results from the unique construction.

Bore of the cylinders is 3¼-inch and the stroke 5 inches for each piston, giving a total of 10-inch piston travel for each charge. The engine weighs 2000 pounds and develops 170 horsepower at 1500 revolutions per minute. Total running range is from 200 to 1500 revolutions per minute. Based on the use of No. 4 furnace oil (though lower grades can be employed if desired) consumption is 0.4 to 0.42 pounds per horsepower hour, this comparing with average gasoline engine consumption of 0.6 pounds. Maximum combustion pressure is 900 pounds per square inch and compression pressure 450 pounds. Actual tests show a maximum exhaust temperature of 300 degrees Fahr.

Positive Blower Used for Air Feed

Similar types of engines have employed crankcase compression for feeding air to the cylinders prior to the injection of the fuel, or have utilized a reciprocating pump for this purpose. In the Stearns engine a rotary blower is used, furnishing air for scavenging the cylinders at a pressure of approximately four pounds.

One of the biggest advantages in having an upper and lower crankshaft, as shown in the cross section, is that uniflow of air is effected through the cylinder in scavenging. As the upper

and lower pistons recede on the firing stroke the four exhaust ports at the bottom of the cylinder are uncovered, and subsequently the four inlet ports at the top. It is obvious that in consequence the inlet ports are open after the exhaust ports close and that as the air flows in under pressure an excess is provided which results in supercharging.

Uniflow of air is especially desirable on two-stroke engines in view of the fact that limited time only is allowed for scavenging and providing a new supply of air. It would be extremely difficult to accomplish this by means of poppet valves and at the same time maintain quiet operation at the high speeds obtainable with this engine. These high speeds, incidentally, are made possible by the thorough scavenging and by complete vaporization of the fuel.

Nozzles Are of Special Design

Special fuel nozzles are utilized and the fuel supplied by a 3-cylinder plunger pump which maintains constant pressure at each nozzle. The nozzles are of the needle valve type, and are operated positively by a tapered sliding cam and tappet.

An ingenious method is employed for controlling the speed of the engine, providing instant response and flexibility within the speed range. Sliding fuel camshafts are mounted at each side of the engine, connected together by linkage, the one at the left being equipped with a control handle as shown in Fig. 1. The cams on these shafts and the arrangement of tappets is sketched in Fig. 4. Increasing the fuel opening is effected by sliding the shaft to the rear, i.e. lengthwise with the engine.

Another feature of general design interest is the method employed to utilize the largest possible effective bearing area for the piston pins and bushings. Inasmuch as with a two-stroke engine pressure acts on the pistons in one direction only—there being no suction stroke—the lower half of each piston bushing has been cut away as shown in Fig. 2. Corresponding to this, the upper half of each connecting rod and its bushing has been cut away at each side leaving only about ½-inch width at the top of the rod. Thus the effective area of the bearing in the thrust direction of the piston is larger in both the piston and connecting rod bushings, the actual increase being approximately one-third more than the amount obtainable with the orthodox design of bearing.

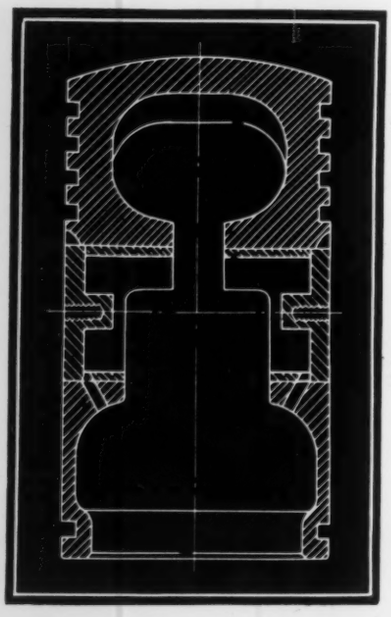


Fig. 2—This cross section of one of the pistons illustrates the unique method of obtaining additional bearing area for the piston pin and bushing

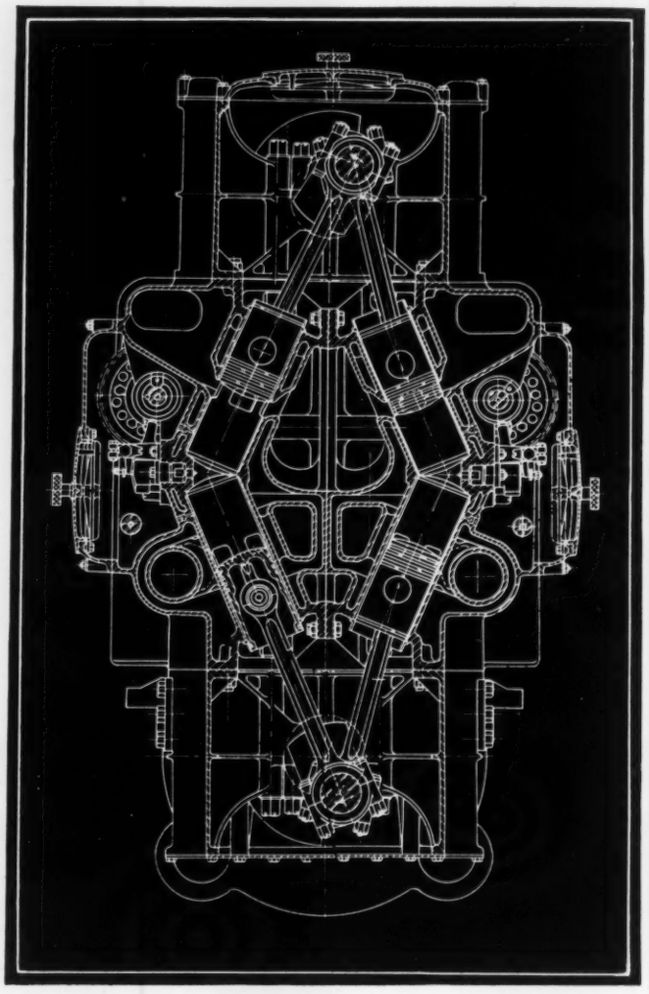


Fig. 3—Cylinders are arranged in shape of diamond around center of engine. Note injection nozzles and fuel camshaft at each side

A particularly interesting feature of the engine is the use of a cast aluminum alloy block, in which are inserted nickel iron alloy dry liners. Tests have shown that the expansion of the sleeves, the cylinder block and the aluminum pistons are similar, which permits not only efficient radiation of heat but also piston tolerances.

Another noteworthy feature is that the engine can be arranged for either diesel operation as at present, using ordinary fuel oil, or can be run on

gasoline injected through the fuel nozzles. For the latter type of operation the only changes necessary are the insertion of spark plugs and the lowering of the compression ratio by the use of different pistons. Tests made over a period of several months on a similar type of engine show this can be accomplished satisfactorily with a compression ratio of 8 to 1 against the ordinary ratio of 5½ to 1 used in the present type gasoline engine.

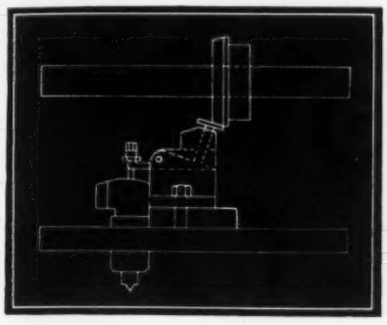


Fig. 4 — Diagrammatic sketch of fuel feed control. Fuel camshafts slide lengthwise with engine and are actuated by single control handle

The engine during operation shows three other characteristics that are particularly outstanding. These are a high brake mean effective pressure of approximately 100, clear exhaust at all speeds and loads, and vibration so slight that a fountain pen placed on end on the unit remains in a vertical position during the entire speed range.

Proposal for New Lock Washer Standard Is Issued

BOTH for appearance and equal bearing area, the lock washer should have outside diameters approximately that of the long diameter of the nut or bolt-head. In accordance with the majority opinion of the committee of the American Standards association which just has released the proposed American tentative standard for lock washers, the thickness of the washer should be as great as is possible to obtain a reasonable and satisfactory spring height of reaction considering manufacturing limitations, appearance, etc.

Consideration was given only to the standardization of lock washers for hexagon heads and nuts. Square head bolts and square nuts require no differently proportional lock washer functionally than the hexagon and, as the square is used largely where appearance is a minor factor, appearance need not be considered in connection with the lock washer used under the square.

Following the procedure of the sectional committee on the standardization of bolt, nut, and rivet proportions, the 3/16-inch size is eliminated, No. 10 being used in its stead both for bolts and screws. Also following this committee's practice, standard lock washers are proposed for wrench-head bolts and nuts in sizes ¼-inch and upward. For the various types of slotted head screws, lock washers are proposed in the following sizes: for round and fillister heads—No. 2 to ⅜-inch, inclusive: for machine screw and stove bolt nuts—No. 6 to ⅜-inch, inclusive. Standardization of lock washers is not carried above 1¼-inch bolt diameter for the reason that the use of these larger bolts is comparatively small and the use of lock washers on such larger bolts is negligible and usually, due to clearance, etc., the lock washers are of special steel sections to fit individual needs.

The proportions proposed for cap screws (Series B) approximate those of the present S.A.E. standard lock washers, however eliminating, in some sizes, defects in the old proportions which have long been apparent and well known. The standards proposed in Series A are comparable to the old S.A.E. standard heavy, but of better proportion, greater reaction, and greater bearing area. A survey of the usage of the old S.A.E. standard light indicated such a small usage of these as not to warrant a separate series to cover.

Dimensions for Lock Washers

Nominal Size	Actual Inside Diameter		Washers for Wrench Head Bolts and Nuts		Washers for Slotted Head Screws		
			Bolt Heads and Regular Nuts, Hex. or Square, Rough, Semi-finished or Finished	Cap Screws	Round Head	Fillister Head	Machine Screw and Stove Bolt Nuts
	Max.	Min.	Series A	Series B	Series C	Series D	Series E
No. 2	0.098	0.088	.....	.....	1/32 X 1/16	1/32 X 0.022	.....
No. 3	0.111	0.101	.....	.....	1/32 X 1/16	1/32 X 0.022	.....
No. 4	0.124	0.114	.....	.....	1/32 X 1/16	1/32 X 1/16	.....
No. 5	0.137	0.127	.....	.....	1/32 X 1/16	1/32 X 1/16	.....
No. 6	0.151	0.140	.....	.....	1/32 X 1/16	1/32 X 1/16	1/32 X 1/16
No. 8	0.178	0.166	.....	.....	1/32 X 1/16	1/32 X 1/16	1/32 X 1/16
No. 10	0.206	0.192	.....	.....	1/32 X 1/16	1/32 X 1/16	1/32 X 1/16
No. 12	0.233	0.219	.....	.....	1/32 X 1/16	1/32 X 1/16	1/32 X 1/16
¼ inch	0.269	0.254	1/16 X 1/16	1/16 X 1/16	1/16 X 1/16	1/32 X 1/16	1/16 X 1/16
5/16 inch	0.334	0.317	1/32 X 1/32	1/32 X 1/16	1/32 X 1/16	1/32 X 1/16	1/32 X 1/32
3/8 inch	0.400	0.380	1/32 X 1/16	1/32 X 1/32	1/32 X 1/32	1/16 X 1/32	1/32 X 1/16
7/16 inch	0.467	0.443	1/32 X 1/16	1/32 X 1/16	.....	.....	.....
½ inch	0.533	0.506	1/32 X 1/16	1/32 X 1/16	.....	.....	.....
9/16 inch	0.596	0.569	1/16 X 1/32	1/32 X 1/16	.....	.....	.....
5/8 inch	0.662	0.633	1/32 X 1/16	1/32 X 1/32	.....	.....	.....
¾ inch	0.791	0.761	1/16 X 1/32	1/16 X 1/16	.....	.....	.....
⅞ inch	0.922	0.891	1/32 X 1/16	1/32 X 1/32	.....	.....	.....
1 inch	1.047	1.016	1/32 X 1/32	1/16 X 1/16	.....	.....	.....
1⅛ inches	1.172	1.141	1/16 X 1/32	1/32 X 1/32	.....	.....	.....
1¼ inches	1.313	1.271	1/32 X 3/16	3/16 X 1/16	.....	.....	.....

All dimensions given in inches.

In accordance with the majority opinion of the committee, the tolerances proposed provide the greatest possible allowance giving due regard to manufacturing limitations, ease of application, and effectiveness.

These standards, shown in tabular form in the table above, supersede all existing standards. While some applications may require other steel sections for a given bolt size, the use of such sections should be restricted to these particular applications and such lock washers should be considered as specials.

Criticisms and comments are invited by the American Standards association, 29 West Thirty-ninth street, New York.

BECAUSE gearing constitutes one of the most popular means of transmitting power, it hardly is conceivable that there are any misconceptions regarding it. However, the efficiency of toothed gearing is much higher than generally supposed, and, as Mr. Himes, manager of the engineering department of Westinghouse Nuttall works points out in this first section of a two-part contribution, many designers do not employ gear trains to their fullest advantage.

Modern Gear Efficiency Exceeds Limits Used in Most Designs

By W. H. Himes

AS THE practice of transmission of power by means of toothed gearing has pyramided rapidly in the last few years, many phases of the gear art are being scrutinized more carefully than heretofore. The old time designer is being asked questions with disturbing frequency which previously were of little concern to him. Probably the development of electric power replacing steam power plants and lineshafting by individual squirrel cage motors has, more than any other influence, forced the development of scientific gear design and construction. The old style slow-speed lineshafts generally could be belted directly to the various machines. But the electric motor does not work effectively at lineshaft speeds, so a demand has arisen for some means of transforming power from 1200 or 1800 revolutions per minute down to 300, 100, 50 or less. Gearing, being the most compact of speed transforming devices, therefore has been receiving unusual scrutiny.

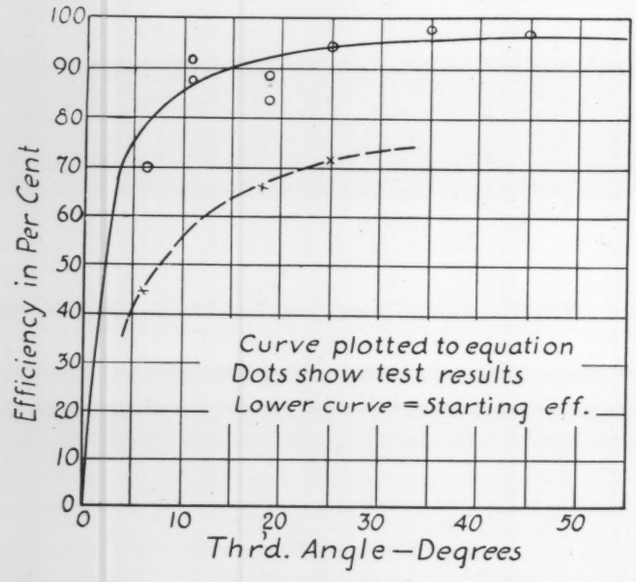


Fig. 1—Chart showing worm efficiency for coefficient of friction of 0.03

Efficiency Is of Prime Importance

Naturally the efficiency of various types of toothed gearing is of prime importance when it is proposed to pass a continuous flow of power, or in other words, dollars, through such a transmission system. The cause of gearing will benefit by a more general understanding of the truth about it, for in general the efficiency of toothed gearing is much higher than is supposed. A well-known mechanical engineer was discussing a proposed design with the writer not long ago, and proposed to allow a 10 per cent loss of power for each train of spur gears in a splash lubricated sealed case, these to be of the most modern generated type. This is an empirical rule which has been inherited from the days of open cast

tooth gearing. If such assumptions still are current, it is probable that many otherwise practical gear applications are being ignored.

Effective transmission of power by means of gears may be affected seriously by the type of gear chosen, its lubrication, ratio involved, and means of securing it, workmanship, and type of bearing. The lower the ratio, the better the chance of high efficiency, and, as a class, worm drives are not as efficient as spur type drives. Strange as it may sound, efficiency of modern enclosed units is as often adversely affected by over-lubrication as by scant lubrication.

Investigates Gear Transmission

Perhaps the best efficiency ever officially recorded in gear transmission is that of a spur set tested at the National Physical laboratory, London. This set was vouched for as 99.7 per cent efficient. Several similar results have been published in America but, so far as known by the writer, they were obtained by private research. Naturally, the next question to arise is: How much variation from such figures may be expected in an ordinary commercial case? Table I is an attempt to answer this question, and it may be said that if the unit falls within the specification given there is something wrong with it if the efficiency does not attain at least the lower limits.

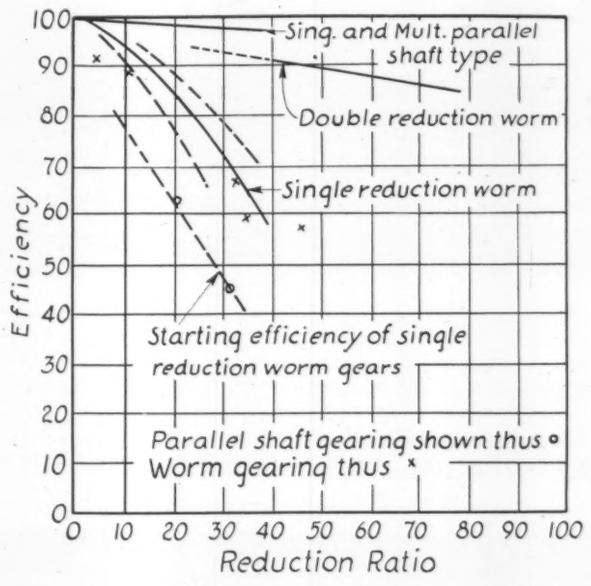


Fig. 2—Relation of gear ratio to efficiency

It is possible that when starting cold, the losses will temporarily be higher than quoted owing to high viscosity of the cold oil. It should be evident from the figures in the table that even when facilities for testing are not available undue heating of the case will be evidence enough of abnormal conditions. The proportions of modern industrial cases are such that a 2 or 3 per cent loss per train can be dissipated without raising the case temperature sufficiently to make it uncomfortable to the hand. The temperature of a normally operating industrial unit generally does not exceed that of the human body.

The writer witnessed an elaborately conducted test of a 125 horsepower double reduction set using roller bearings, where recorded efficiencies varied between 98 and 99 per cent. The first set of these gears was of the single helical type and the second was of straight bevels. Mr. Day of the Falk company states that they once had the opportunity of testing a pair of their marine type staggered tooth herringbone gears. This was due to the fact that they received an order for a twin set. Thus by using one set as a step down and the other coupled to it as a step up, the power emerged from the high speed pinion of the driven gear at a speed and torque which readily was measurable. Result: 98.8 per cent efficiency per unit (assuming the losses to be divided equally).

TABLE I

Spur or Single or Double Helical Gears In Oil Tight Cases

	Antifriction bearings		Journal	
No. of Reductions	Starting Loss	Running	Starting Loss	Running
Single	1—2%	0.5—1%	10—20%	0.5—1.5%
Double	2—4%	1.0—2%	15—25%	1.0—3.0%
Triple	3—6%	1.5—3%	20—35%	1.5—4.0%

Losses Multiply as Ratio Increases

Thus it will be seen that modern parallel shaft gearing is unsurpassed as an efficient means of transforming power. The efficiencies quoted are for moderate ratios. The losses multiply as the ratio increases. It may be said in general that the efficiency of all parallel shaft gearing is about the same regardless of whether the gears are of the spur type, helical, or herringbone. In practice, it is impossible to detect any difference between spur, helical, or herringbone gears by any test yet devised. The bevel gear is nearly as efficient as the parallel shaft type, but not quite. Such data as there is indicates a slight difference in favor of the latter. Given the same accuracy of generation, there should be no difference, but the bearing thrusts developed probably account for what difference is observed. The skew or hypoid bevel is in a slightly lower efficiency class than those bevels which have intersecting axes, due to the lateral sliding motion developed by the teeth.

The most controversial class of all gearing is the worm drive. Some very confusing claims and counter claims are made in regard to this type. The truth is that in no other class of gearing does the efficiency vary so widely. Here it may be said that all the elements which may affect performance with other types only in a microscopic degree, may become glaring in their

importance. The efficiency of a worm drive is determined by the following four conditions, named in the order of their importance.

Lead angle—which is a function of the ratio and which determines the number of threads on worm

Kind of lubricant
Workmanship or degree of finish, and
Material

Another way of expressing the same condition is—efficiency of a worm drive depends upon the lead angle and the coefficient of friction. This latter may be varied somewhat by the kind of lubricant, and the other two items just mentioned.

In Fig. 1 is shown the theoretical relation between lead angle and efficiency. This is only one of a series of such curves which may be plotted on the assumption of different coefficients of friction.

The equation for this curve is,

$$e = \frac{\tan \alpha \ (1 - \mu \tan \alpha)}{\tan \alpha + \mu}$$

where

e = efficiency
α = lead angle
μ = coef. of friction

The derivation and a discussion of this equation may be found in Kimball & Barr.

The assumption made in this case is, $\mu = 0.03$. This is used here because many independent tests have shown that it may be attained readily in good industrial practice. An inspection of the curve shows that little is gained by making the lead angle any higher than 25 degrees. Also that for power transmission anything less than 15 degrees generally would be inadvisable. The large losses would involve bad heating conditions. Therefore high duty power worms may be found to fall in a ten degree range. For geometric reasons it is not practical to construct even a 15 degree worm with less than 2 threads, so efficient worm drives for continuous duty are seldom of less than 2 threads and more often of 2 to 5.

There are many industrial uses for the single thread worm, however. Obviously these are where effective use of energy does not count so much as high reduction ratio or the property of self-locking. This self-locking property will be enlarged upon later.

The lubricant may cause a variation of 8 to 10 per cent in efficiency without causing actual failure. The most widely used lubricant is mineral oil of 600 flash test, or the so-called 600W of trade. This is by no means the best, from an efficiency standpoint. On a recent test the writer found that by substituting castor oil for 600W, the efficiency was raised 8 per cent. However, castor oil has several drawbacks and it may be said of the other oil that it does protect the rubbing surfaces satisfactorily, and it is cheap and universally obtainable. A book could be written on this phase of the subject.

Buffing Improves Efficiency

By workmanship is meant the degree of precision with which the worm and gear are formed. A slight but well defined improvement in efficiency may be secured by buffing the surface of the worm threads.

Finally, bronze gives better antifriction qualities than cast iron, and phosphor bronze is better than manganese bronze. Unfortunately, phosphor bronze is by no means the strongest of the nonferrous metals, so manganese or some other alloy sometimes is resorted to for extra strength. A specific example of an excellent gear bronze has: 89 Cu; 10.5 Sn; 0.2 P; 0.4 Ni. It is well known among designers and mechanics that ordinary steel running against steel is as impossible with worm gears as it is for a bearing combination. Lead angle may be considered from several

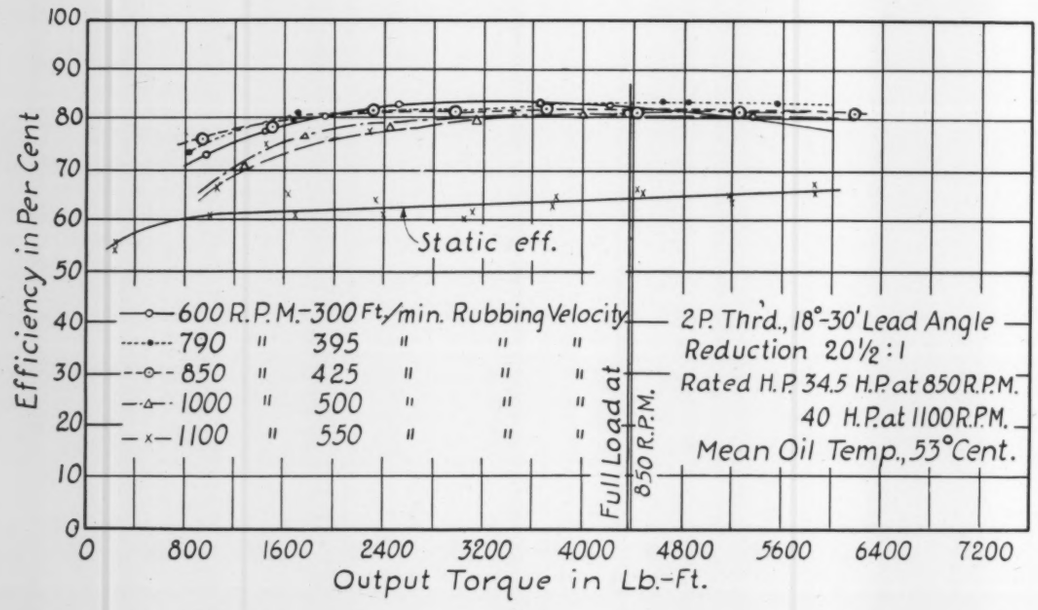


Fig. 3 — Efficiency characteristics for gears run at a fixed speed while load varies over a wide range. Relation between static and running efficiency is shown clearly. The chart indicates that, in the speed range tested, speed has little effect on efficiency

viewpoints. From a geometric view it will be evident that the smaller the pitch diameter of the worm, the steeper the lead angle for a given circular pitch, so worms which are integral with the shaft, and which thus can be made much smaller in diameter than separate worms always are resorted to, and attain the highest efficiency. Of course, the separate worm and shaft constitute the cheaper construction.

It has been hinted that ratio has an important bearing on worm gear efficiency and the reasons will now be considered. After choosing a pitch sufficiently great to carry the load the threads must be wound around a worm core of sufficient diameter to withstand the deflection and torque stresses involved. Now the maximum ratio is obtained by using a single thread worm which will advance the gear one tooth per revolution of the worm. But single thread worms are inherently of low lead angle and, therefore, they are of low efficiency, even when wound around the smallest diameter of core that will supply the necessary rigidity. As soon as the number of threads is doubled to raise the efficiency, the ratio is cut in two.

Design Is Becoming Uniform

Before these principles were understood, designers frequently chose worm diameters far in excess of that necessary for strength, so that ratio and efficiency were not co-ordinated clearly; but today if two designers are given the same specifications they will choose nearly the same core diameter for rigidity and they will not vary much in the pitch selected for strength of teeth. It is not surprising, therefore, that when results of efficiency tests are plotted against ratio on the chart, Fig. 2, the results lie on a well defined curve. Thus it is not necessary to wait until a lead angle has been chosen before predicating closely the probable efficiency of any given ratio. Tests covered by the chart were not confined to units made by one manufacturer. Several sets were of the automotive type, but the majority were for industrial use.

All values in Fig. 2 are for the condition of maximum performance. In other words the highest point on the curve in each case. The chart is intended to show in a general way how spur type and worm gear efficiencies depend upon ratio. The line for spur gearing represents multiple as well as single reductions. An inspection of the chart shows at once that spur type gears hold up in efficiency very well at high ratios, while worm drives, as might be expected, fall away in efficiency as the ratio increases. Owing to the fact that a single thread worm is perfectly practical while a single tooth pinion is decidedly impractical and at best only a freak, it is possible and practical to attain a ratio by a single reduction worm gear greatly exceeding what is practical with spur type gearing.

The simplicity of worm construction often leads the designer of gear trains to resort to this construction to attain a high ratio in spite of the losses involved. Thus by the chart it can be seen that a ratio of 50 to 1 is not abnormal in worm gearing while spur type practice in speed reducers usually stops around 10 to 1, and rarely reaches 20 to 1, even in freak designs. (Single

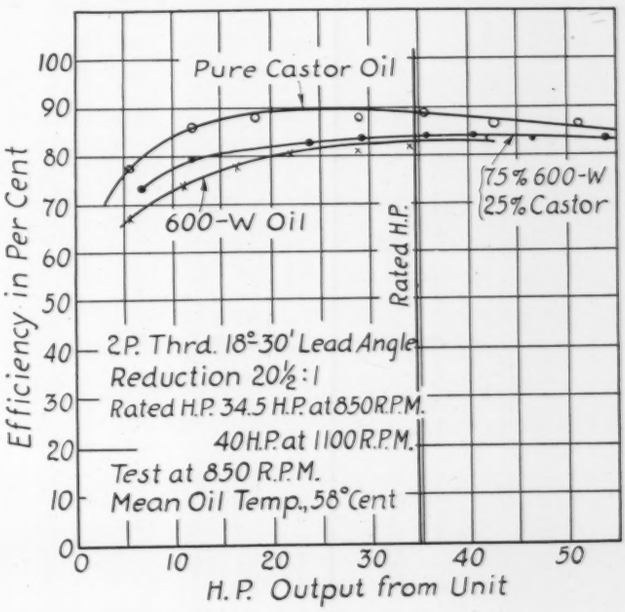


Fig. 4—Wide variation is possible with different lubricants in the same case

tooth herringbone gears have been constructed, and any limit here set may be deliberately overstepped, and justifiably so to meet peculiar conditions). Yet if one persists in holding to a single reduction worm drive for a 50 to 1 ratio, he must be content with great loss of power, while if he will combine two low ratio units, he will attain the same end with much more effective transmission. The exact ratio at which the designer should double up depends on the circumstances.

On the chart, 40 to 1 is the point where this doubling of units is started, as it is assumed that one ordinarily would not stand the expense of a double worm drive at a lower ratio. This does not mean that an appreciable saving of power is not possible at lower ratios, and the possibilities of the double reduction are shown by the dotted portion of the curve. However, spur type gears lend themselves readily to multiple reductions in one unit whereas the multiple worm reduction is unwieldy and expensive in comparison.

The important point to be held is, that while worm drives are efficient at low ratios they are sensitive to the ratio, and the efficiency falls off rapidly as the ratio increases. A great deal of confusion has arisen from the fact that capital sometimes has been made out of efficiency tests which have been conducted on these low ratios.

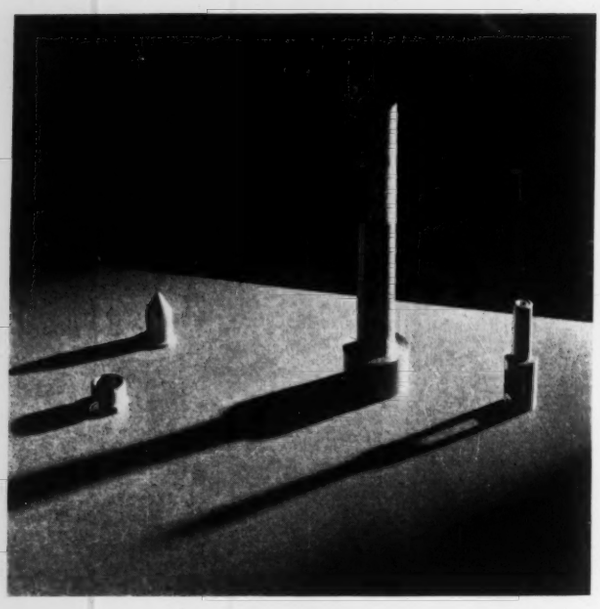


Fig. 1—Screw machine products of alloy steel can often be fabricated for less cost than the same parts made of carbon steel

Selecting Steel Intelligently

By H. E. Mack

SELECTION of the proper material for machine parts always has been a difficult problem. When James Watt was developing the steam engine he experienced great inconvenience in obtaining the materials required for his purpose. Other early pioneers also were handicapped by the lack of ferrous and nonferrous metals of the kind and quality required for their applications.

Today the situation is reversed. With few exceptions the problem is not one of scarcity of materials but, on the contrary, it is one of selecting from the superabundance of kinds, grades and qualities the one best fitted to the job.

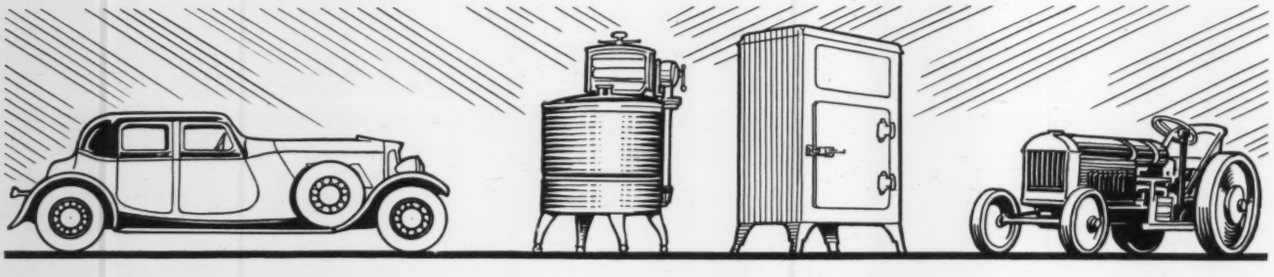
Many efforts have been made during the past two decades to assist engineers and others engaged in design in selecting materials more intelligently. Several technical organizations have established standard specifications intended to classify widely used materials. In the field of iron and steel the specifications of the Society of Automotive Engineers, American Society for Testing Materials, and several railroad associations are recognized and used by the majority of buyers and sellers of iron and steel products.

Designers of machines and machine parts deal largely with S.A.E. and G.M.C. specifications because these data cover most of the steel commonly used. They are based on a numerical index system which gives a clue to the approximate content of carbon and, in the case of alloy steels, the predominant alloying element. In other words, the specifications place the major emphasis on chemical analysis.

It is conceivable that a manufacturer of machines favored with personnel highly versed in metallurgy and having considerable experience in heat treating and other finishing operations may be able to select steels intelligently from S.A.E. or G.M.C. specifications. This technical knowledge was necessary some time ago in the automotive industry when it became incumbent upon the builders of motor cars to demand new steels because those of the required properties were not available.

Now, however, with steels available for every reasonable requirement, it is not necessary, nor

Fig. 2—Designers of these and other machines may realize worthwhile savings by careful selection of the right steel



is it desirable, that the purchaser of steel make his selection through the tedious process of working back from physical to chemical requirements. Fortunately for the great number of companies engaged in the manufacture of machines and machine parts, it is possible to obtain highly satisfactory results by placing major emphasis upon the physical properties desired.

New Developments Obsolete Standards

This fact can be illustrated by a study of the table which shows the chemical analyses, physical properties and prices of ten typical steels covered by S.A.E. specifications. This group is widely used in the form of cold finished bars where strength, response to heat treatment or case hardening properties and machinability are of prime importance. In countless applications, however, new developments have rendered obsolete these recognized standards by providing increased machinability, improved case hardening properties, greater strength, or sufficient strength at less cost.

At this point it may be well to discuss the viewpoints of various individuals as to what constitutes the best steel for a given job. The purchasing agent is likely to place considerable emphasis on price although, of course, he is obliged to keep in mind the fact that material must conform to certain standards prescribed by the engineering or operating departments or both. Engineers charged with the responsibility for design are certain to be guided by a desire to use only a steel which will meet the engineering requirements. The works manager will prefer the steel which gives him the least trouble in heat treating and machining.

Considering the preferences of these three authorities, and keeping in mind also what is best for the institution as a whole, it is safe to say that in the final analysis the best steel for a given purpose is the one which will provide finished parts at the lowest cost with no sacrifice in utility or service.

Obviously such a steel cannot be selected on the basis of chemical analysis alone. It is necessary not only to take into account the prices of the various materials, but also the various factors which affect prices such as extras for finish, tolerances, allowable variations in analyses, etc. Knowledge of the relative machinability as well as of the important physical properties is essential. In view of these many factors many companies are finding that in the great majority of cases it is better to furnish the supplier of steel with blueprints and other information on the job to be done rather than to order the steel blindly. The wisdom of this policy is demonstrated by the experience of a steel company which studied intimately the wants of purchasers of steel for machines and machine parts.

WHEN it is possible to effect savings by the use of a new steel that are greater than the actual cost of that material, it behooves every designer to investigate carefully the finished cost of a part made from various steels available. Mr. Mack, vice president, La Salle Steel Co., ably presents the case of economies effected by high first cost steels versus materials with a lower first cost.

It was found that many manufacturers had not been using the most desirable steels available. In one case an automobile company had been using S.A.E. 3115 steel for piston pins. An investigation proved that all requirements as to uniform surface hardness, strength and core toughness could be met successfully with a high-manganese case carburizing steel. The specification was changed and the cost per piece including overhead was reduced over 2 cents.

Production Increased Materially

In this case the saving was as much in the cost of the steel as in the cost of machining. Production per man hour for drilling and forming the taper hole on both ends was increased 46 per cent; milling of the slot in the pin was speeded up 48 per cent; chamfering and cut-off operations were performed at the rate of 171 per cent as compared with previous practice. These marked reductions in labor cost coupled with the reduction in material cost made it possible to effect a saving per ton greater than the actual cost of the new steel.

In another case an oiler for a drive chain,

Ten Typical S. A. E. Steels

Specification	Properties	Price, per 100 pounds
Shafting	Transmission and machinery shafts	Carbon base
S.A.E. 1112	Free machining for screw machine parts	$.10 extra
S.A.E. 1120	Compromise between machinability and case hardening properties—screw stock	$.10 extra
S.A.E. 1020	Standard case hardening steel	$.15 extra
S.A.E. 1035	Medium strength steel	$.25 extra
S.A.E. 1045	High natural strength material increased by heat treating	$.25 extra
S.A.E. 3120	Poor machining, good carburizing alloy steel	Alloy base, $.55 extra
S.A.E. 3135	Poor machining, good heat treating alloy steel	Alloy base, $.55 extra
S.A.E. 2320	Good carburizing, tough core alloy steel	Alloy base, $1.50 extra
S.A.E. 2340	Strong, tough steel when heat treated	Alloy base, $1.50 extra

formerly made of S.A.E. 1112 steel, was changed over to a freer cutting bessemer screw stock. The cost per piece was reduced in excess of 33 per cent, the saving per ton again exceeding the cost of the raw material.

A manufacturer of transmissions employing S. A. E. 1020 for guide rails was experiencing many rejections due to nonuniform case hardening results and surface imperfections. A modification in steel analysis eliminated both these difficulties at no increase in cost of raw material.

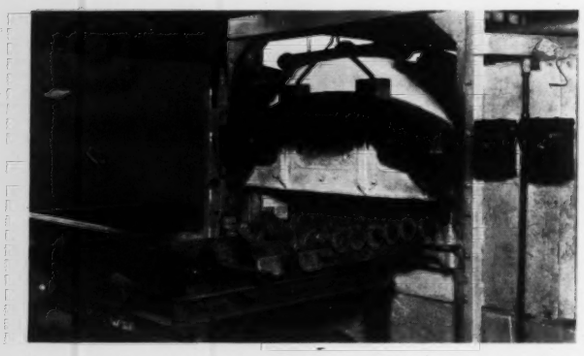


Fig. 3—Heat treating of the final part may be eliminated by use of steels heat treated in the bar

Countless illustrations might be quoted, but to sum up briefly, results show that 20 to 40 per cent and as high as 60 per cent increased production has been obtained on screw machine parts when produced from the newer specifications in both bessemer and open-hearth steels. Savings of 10, 20 and 30 dollars per ton often have resulted from the replacement of the older recognized high priced steels, while rejections in many cases have been eliminated almost entirely.

Many Types Are Wasteful

Sometimes manufacturers waste money in specifying a number of steels differing only slightly in properties when fewer types would serve just as well. A maker of fine clutches found that he could replace his former specifications involving seven grades with two new grades. The net result was a reduction in cost of material, savings in machining costs, improvement in the physical values of the finished parts, reduction of inventory float, reduced cost of stores and orders, better delivery dates and lowered freight and handling charges.

For a number of years the engineering trend has called for the use of increasingly lighter and stronger parts. This movement has been accentuated by the needs of the automotive industry and the result is a constantly growing use of heat treated parts made from both carbon and alloy steels. In the majority of cases the steel has been fabricated in its natural condition and the heat treatment applied to the machined part, necessitating a final cleaning and straightening operation.

The possibility of correcting "parts" failures or increasing the strength and capacity of machines without change of design is well worth serious consideration. With improved machining tools, combined with freer cutting steels, it is now possible in many applications to employ steels heat treated in the bar to the desired physical properties. Thus, not only worthwhile economies are achieved but the use of heat treated parts is simplified for the average manufacturer.

Designers Must Keep Up-to-Date

Aside from considerations such as the foregoing there is the important problem of keeping abreast of the improvements which are being made in the metallurgy of steel. Several steels developed in recent years and proved satisfactory by ample performance are not yet recognized by standard specifications. Users of steel who are reluctant to try these materials simply because they are not listed in the handbooks are making a grave mistake. In some cases they are arbitrarily closing the door to real opportunities for saving.

In many industries it is possible to find on high priced models of machines parts made of steel costing considerably less than that in the corresponding parts of low priced models. When this situation exists it usually means that the manufacturer of the lower priced machine is paying unnecessary tribute either to a personal reputation or to tradition.

Suppliers of steel have not always been anxious to look at customers' blueprints for the purpose of helping them in their choice. At times in the past the steel industry was so notoriously uninterested in consumers' requirements that certain large users virtually were forced to write their own specifications and to plead with the producers to supply them with the type of steel required.

Today the situation is different. Many companies, and especially those handling steel for machine parts, are better equipped than ever before to diagnose the customer's problem and prescribe for his requirements.

Bearing Resistance Tested

TESTS of the frictional resistance of bearings are reported in a recent publication of the University of Wisconsin, Madison, Wis., entitled "Friction of Some Babbitt, Roller, and Ball Bearings," by Edward R. Maurer and L. E. A. Kelso. The booklet describes the tests, which were conducted over a period of years, the equipment used, and gives results and conclusions drawn. Copies may be obtained from the Engineering Experiment station of the University, at Madison for 50 cents.

Hydraulic Drives

Must Incorporate a Slippage Factor

By Carl Morey

Consulting Engineer, Big Rapids, Mich.

THE application of hydraulic transmissions to industrial equipment other than presses or similar machines literally had its birth just prior to the World war. The war, however, retarded its development, and postponed its general acceptance by engineers and designers for a number of years. At this time several builders of hydraulic equipment instituted an intensive sales campaign that resulted in an epidemic of hydraulics on industrial equipment, notably machine tools.

It became generally known that a flexibility in drives could be obtained that was without parallel. Engineers and builders in large numbers were convinced that a "cure-all" had been discovered, and in some cases brought out machines known as "full hydraulic," frequently applying hydraulics without economic or scientific justification.

Type of Application Controls Success

Many of these machines are in successful operation today, while others have been consigned to the junk pile. The reason for this difference is simple, as in the former case the type of machine lent itself to application of hydraulic principles, while in the latter classification it did not. At the present time some builders are wasting time and money on hydraulic applications which are not justified. Others are overlooking possibilities where hydraulics would reduce first cost materially in addition to effecting a marked improvement in the equipment being built.

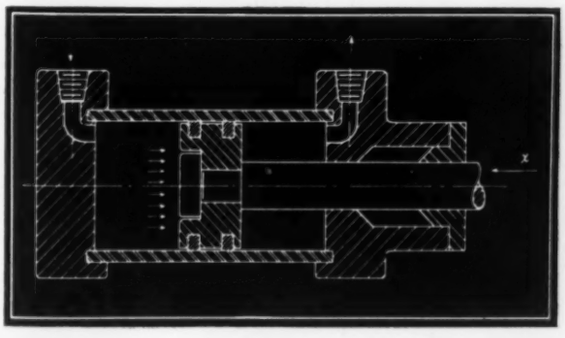
Since hydraulic drives have definite characteristics and limitations, an analysis of the working conditions of a particular machine should be made before deciding if hydraulics are at all suitable. This analysis also should determine the exact type of units or hydraulic system best suited for the performance characteristics of the machine.

The importance of this analysis is paramount, for, if incomplete, it frequently causes unnecessary development expense and service costs, and an enlargement of the junk heap. Stressing this point a little further, it is safe to say that at least 70 per cent of the failures of hydraulics in industrial applications is caused by application to conditions totally unsuited, or use of the wrong type of equipment or system of hydraulics.

In making this analysis, the following points should be considered. If the drive requires absolute synchronism, hydraulics are not suited. If, however, a slippage factor is permissible, the next question to be answered is, how large a slippage factor can be permitted? If it must be smaller than 1 per cent, then the highest type of hydraulic equipment is necessary. The relative cost of hydraulic compared with mechanical drive should then be determined.

Suitable for Wide Speed Range

Should a wide range of speeds be required the problem is favorable for hydraulics. If the slippage factor can be as large as 4 or 5 per cent much lower priced hydraulic units are adaptable. Should the speed range be acceptable in steps, a further reduction in the cost of hydraulic equipment can be effected. If the power require-



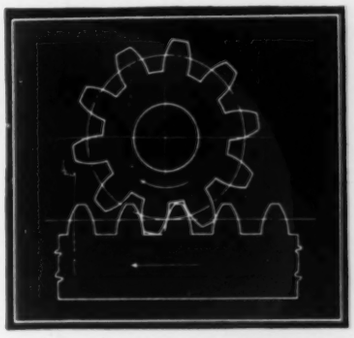


Fig. 1—a—(Left)—Movement is proportionate to amount of fluid less amount of leakage. b—(Right)—One revolution of pinion moves rack exact length of circumference. This positive movement is not practical with hydraulic equipment

ments are relatively low the throttling method can be adopted with a still further reduction of costs.

The subject hinges on the matter of inherent characteristics of fluids and equipment used in hydraulic drives. In general, where operating devices will allow for a slippage factor, hydraulics frequently will reduce construction costs and improve the general functioning of the machine. Where a slippage factor is not permissible, it is utterly impossible to apply hydraulics with success.

Leakage Necessitates Slippage Factor

An explanation of this slippage factor should prove of value. It is an established fact that if a rack is driven by a pinion the rack will move in an absolute relationship with the pinion. It is equally established that if a fluid is introduced into a cylinder to push a piston there is a loss due to leakage, Fig. 1, *a* and *b*. In the case of *b*, one revolution of the pinion moves the rack a distance equal to the pitch circumference of the pinion. In *a*, the movement will be proportionate to the amount of fluid less the amount of leakage. The efficiency then equals the theoretic volume required to move the piston a definite distance divided by the actual volume required to move the piston an equal distance.

It also is known that if the pinion is held without motion, the rack likewise will be held without motion. If, however, the flow of the fluid to the cylinder is stopped a sustained pressure at *X* in the direction indicated by the arrow will cause the piston to return to the rear of the cylinder as the fluid will leak around the piston. Many successful types of packing have been introduced to reduce this leakage, but none of them give absolute stoppage.

Since it is impossible to predetermine this leakage, the leakage factor is unknown until after the device is built. Even then it may vary between wide limits due to numerous causes beyond the control of the designer. Many devices have been developed with more or less success to compensate for these fluctuations, but the best of them does not produce absolute duplication such as obtainable with a train of gears.

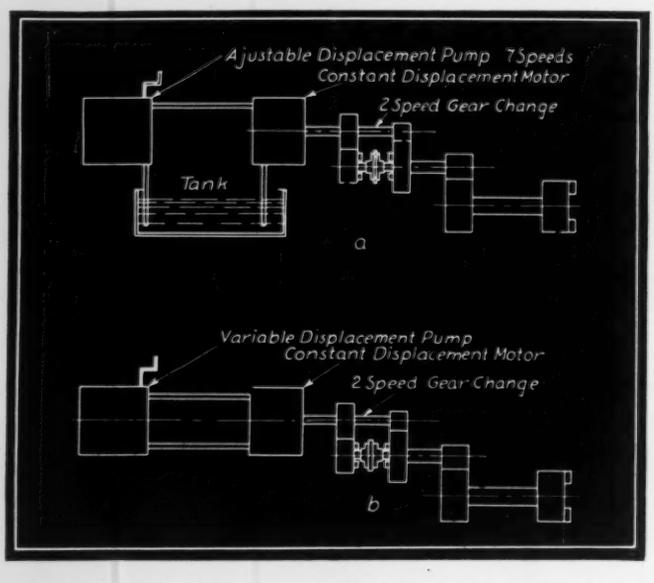


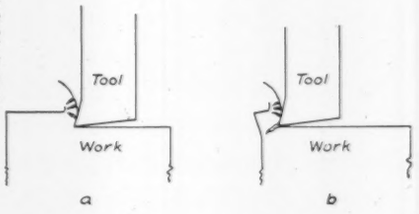
Fig. 2—a—Practical system suitable for many drives where speed in steps is acceptable. b—Same drive using variable displacement pump

Internal leakage occurring in any hydraulic unit may be caused by a combination of several reasons. It is the one element that contributes most to the troubles encountered with any hydraulic system. Among the more important causes for internal leakage are manufacturing and running clearances, and pressures of fluid.

If this factor of leakage were constant, it would be a simple matter to determine by experiment its amount and design for it, but it varies between relatively wide limits. There are variations of viscosity of the fluid, variation of clearances due to unequal expansion and contraction of mechanical parts, varying pressures and varying velocities of fluid.

The variations caused by temperature change are most important since they not only affect the fluid viscosity but the unit itself. Thermostatic controls have been devised to compensate for some of this variation. They have contributed something towards pushing up the hydraulic efficiency but the units as a whole, including these various compensations, still have a slippage factor which keeps them in the nonsynchronizing class.

Fig. 3—Resistance is removed from the system when a tool runs out of a cut, as at b, thus changing the velocity rapidly



Few Drives Require Synchronism

In general, a small percentage of the primary or intermediate drives of machines requires synchronism. An infinitely greater percentage of these drives can tolerate a small slippage factor without impairing the utility of the machine.

In the former instance, the carriage drive of a lathe when threading must synchronize *exactly* with the headstock drive; a slippage factor is not permissible. In the case of a cam-operated machine where a series of motions must be positioned and timed exactly, the machine will not function satisfactorily when a slippage factor is introduced.

In the latter instance, boring or turning feeds (when not threading) will permit of a slippage factor if it is kept within certain limits. The work on a grinding machine table does not have

to synchronize with the grinding wheel. The surface velocity of the work on a polishing machine can fluctuate 5 per cent without detrimental results. Likewise, a conveyor drive or any other drive that can be driven by an electric motor with its 4 per cent slippage factor is suitable for hydraulic drive applications.

Usually, a slippage factor in excess of 4 per cent is permissible. The cost of equipment with a small slippage factor is relatively high as compared to the cost of equipment with a large slippage factor. In the latter case this value may reach as high as 12 per cent on poorly designed and constructed apparatus.

Yet, if it is known that the efficiency of a pump and motor is around 90 per cent, it is a simple matter to design it 8 or 9 per cent oversize to take care of the error and still produce an eminently good device. It will not, however, produce perfect synchronism, but that is known, and the cases where perfect synchronism is required are avoided carefully by the designer considering hydraulics.

In summing up this phase of the subject, hydraulic equipment is available having slippage factors well within 1 per cent. Despite this, why not design 3 or 4 per cent into the machine on any drive where a 1 per cent variation is tolerable? The relative cost of hydraulic pumps and motors may be as great as 1000 per cent in favor of the 4 per cent slip hydraulic units.

Multiple Cylinder Units Employed

Practically all of the high efficiency hydraulic units on the market are of the multiple cylinder and plunger type. These units have all the diseases of the simple cylinder and plunger. They usually incorporate the variable displacement feature, which is, of course, important where large volumes and high pressures are encountered. The importance of this variable displacement feature has been somewhat exaggerated, since there are very few motions in industry where total speed variation is required.

On small capacities and for pressures less than 1000 pounds per square inch the throttling method is satisfactory, while for larger volumes a reasonable number of steps in the working range is acceptable. The high pressure characteristics of certain hydraulic systems are not universally acceptable, as the control of fluids at pressures in excess of 1000 pounds per square inch becomes increasingly difficult. It usually is more economical to use low pressure rotary equipment and introduce a limited amount of gearing to secure the required torque.

Relative to the matter of introducing gearing in connection with a hydraulic rotary motor, much can be said in its favor.

Primarily, all hydraulic systems are spring loaded, since a spring loaded relief valve is

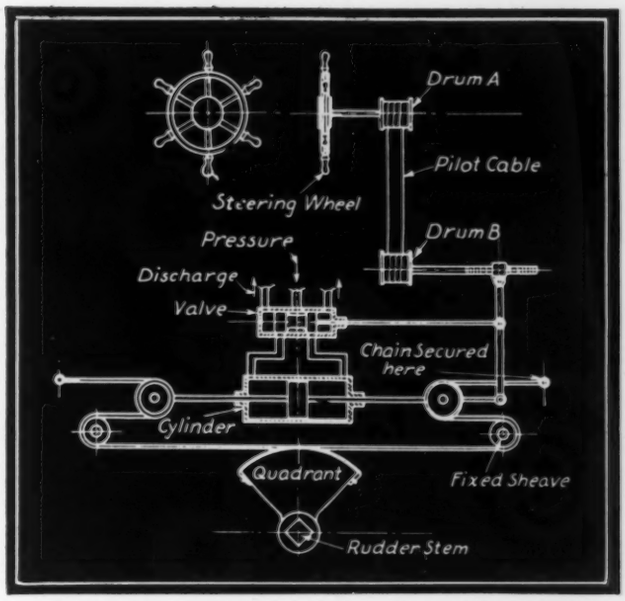


Fig. 4—Hydraulic operation proves especially suitable for steering gear mechanism

present in all systems. In addition all liquids have a definite compressibility. If pressures run high, the resilience of the piping is to be added as well as the straightening effect on pipe bends at high pressures, and the compressibility of air in suspension in, and gassification of, the liquid. All of these elements contribute to a fluctuation in the system.

Various means have been developed for compensating for, or eliminating these objectionable elements. For the relief valve there is no cure, as that is the protection of the system and no system should be designed without it. Likewise, the compressibility of the liquid is inherent although it may be reduced by lowering the pressure and increasing the strength of the pipe.

Allow Air and Gas to Escape

The straightening effect of pipes can be reduced by reducing the number of bends. Air and gas frequently are allowed to escape by means of bleeders, yet the system still remains a fluctuating one. The most distressing troubles experienced with cutting machine tools can be traced directly to these causes. When the tool runs out of a cut, Fig. 3*b*, its velocity changes rapidly since the resistance has been removed from the system. The direct results are the rounding over the run-out edge of the work on planer and miller type machines, and the tearing action on the breaking through of a drill on an hydraulically fed drilling machine. Also, the resilience contributes to chatter, and a small variation in the cut proper depending upon the varying density of the metal being cut. In all, it has a character similar in every respect to a weak drive, one in which the torsional "wind up" is excessive.

The introduction of gears helps considerably

since they act as a dampener. It is well understood that it requires considerable force to change the velocity of a gear train momentarily. The action is exactly the same as if a gear tooth of one of a train of gears is hit with a hammer. The tooth probably would break without introducing a perceptible movement to the train, due to the inertia. This is the manner in which a gear train dampens the jump effect at the end of a cut.

With a variable or an adjustable displacement pump for securing the speed changes, an economy can be effected over the conventional change gear system. Fig. 2*a* shows a practical system suitable for many drives where speed in steps is acceptable, while Fig. 2*b* shows the same drive using a variable displacement pump in place of the adjustable displacement pump. It will be noted that at *a* a seven-step pump is used in connection with a two-speed change gear securing fourteen speeds on the spindle. In *b*, due to the two-speed change gears, the size of the variable displacement pump and motor can be reduced as it operates at higher speed. The saving here will more than compensate for the cost of the gear change which is introduced to build up the torque at low speeds.

Attempts have been made to use the poppet type relief valve arranged so that it remains tightly closed during the working cycle, opening only when the pressure becomes excessive, such as twice the normal working pressure. This of course, is impossible in both theory and practice, although it has its drawbacks. Among these is the fact that as soon as the valve cracks there is a momentary extremely high velocity of fluid passing between the valve and the seat causing "wire drawing." This causes cutting of both valve and the seat.

Pressure Must Build Up

In addition to this, due to the fact that the moment the valve opens the pressure immediately drops, it allows the valve to close until the pressure is built up high enough to open it again. The time required for this is extremely small so the valve develops such a high period of vibration that it becomes noisy, the frequency causing a whistling sound. This also contributes considerably towards heating the fluid, with the results as described in the foregoing. Another objection to this type of valve is that the hydraulic impact is increased when the valve in the pressure line is closed. This necessitates other devices having a dampening effect.

The piston type relief valve is spring loaded at all times. It cannot operate rigidly during the working cycle as does the poppet type described, but it has the advantage of being quiet and reduces "wire drawing."

In applying hydraulics to any movement the designer must determine whether throttling is possible, or whether he must go to more expensive equipment. Usually this is decided by the loads moved, and the rate at which they are moved. In general, 10 horsepower is the maximum that can be handled with a throttling system, but this is high and must be worked out carefully if the equipment must operate over considerable periods in a throttled condition. The following rules will be of assistance for determining if throttling will be satisfactory.

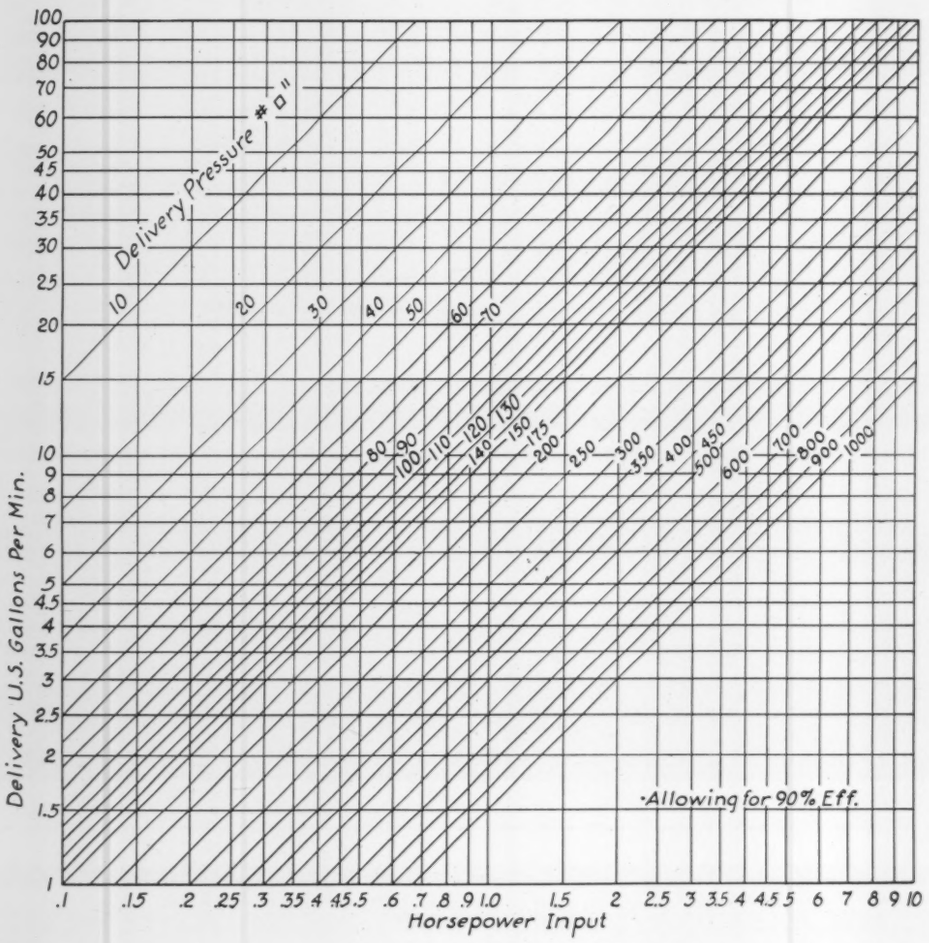


Fig. 5—Factors of horsepower, gallons per minute, and pressure may be determined from this chart

Working pressure × U. S. gal. × 1 min.=10,000 (or less). The quantity of oil should be at least large enough that it passes through the system not more than once per minute.

Theoretically, it requires 0.00058 horsepower to pump 1 gallon (U. S.) against 1 pound pressure in 1 minute. Then, with a constant of 10,000 (gal. × lb.) we have 0.00058 × 10,000=5.8 H. P. maximum for a system where extensive throttling occurs.

The designer must determine the extent of throttling, for, if it is very limited, more power can be transmitted without excessive heating taking place.

Throttling is resorted to in the hydraulically actuated stoker shown in Fig. 6. Pressure is generated by a gear pump and passes to the relief valve, throttle valve and reversing valve. The pressure then is selected for either the feeding motion or charging motion of the piston and pusher. Wide variations of speed are required by the pusher in the feeding direction.

Determining Design Information

The accompanying chart, Fig. 5, will be of assistance in determining the factors of horsepower, gallons per minute, and pressure. It is based on 0.00066 horsepower per gallon per minute per pound so that it is about 10 per cent high. This usually provides for a certain amount of hydraulic friction, etc.

Referring to the throttle valve, there has been some discussion as to its proper location with reference to the motor. With the throttle located on the discharge side of the motor, speed is regulated by varying the resistance in the system by building up a back pressure against the motor thereby decreasing the total effective pressure. With the throttle on the pressure side of the motor, the quantity of fluid acting directly upon the motor is regulated, the resistance remains constant and back pressure is eliminated. In both cases, the excessive fluid passes out through the relief valve. Either way is satisfactory since both systems have been used with success.

A "follow-up" valve is incorporated in the usual form of hydraulic steering gear, Fig. 4. When the steering wheel is turned, the power is transmitted to the screw by means of the drums *A* and *B* and the pilot cable. As the screw turns the nut is moved, thus opening the valve and admitting fluid under pressure to the cylinder. When the piston begins to move it has a tendency to close the valve. A lead in the valve is maintained while the steering wheel continues to move. When the wheel stops the valves remain open until the movement of the piston closes up the lead and the mechanism is stopped. Power is transmitted to the rudder quadrant by means of a chain. Fig. 4 shows the midposition.

Experience has shown that low pressure hydraulics are more satisfactory than high pressure hydraulics. This, of course, applies particularly to medium and low power deliveries. Low pressure equipment (1000 pounds per square inch and below) is more inexpensive than high pressure equipment. Frequently, builders of high pressure units recommend their use for low pressure operation. This is totally unjustifiable since excellent low pressure units are available in the open market and a further saving may be effected if the machinery builder makes his own hydraulic units.

The low pressure equipment available is suitable up to about 25 horsepower. Beyond that figure the designer must resort to high pressure units. The reason for this is due largely to the fact that the great quantities of fluid that must be moved at the low pressures to secure the desired

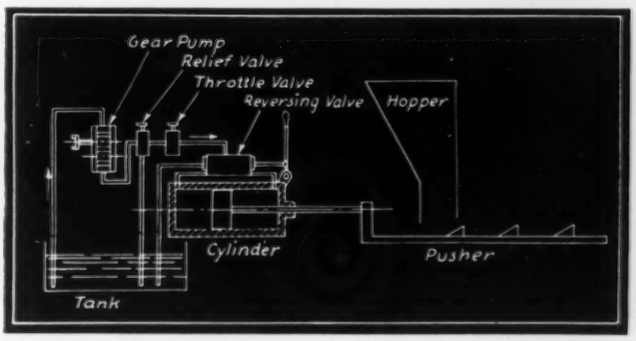


Fig. 6—Hydraulic pressure is generated by a gear pump on this stoker

power delivery either build up the velocity of the fluid with consequent losses and low efficiency, or require large, clumsy units and large pipes. The expense becomes excessive so the small high pressure units are favored.

All Types Have Definite Field

There are fully as many applications suitable for hydraulic applications above 25 horsepower as there are below that figure, so there is a definite field for each of these types of equipment.

Designers and builders who have pioneered high pressure industrial hydraulics in this country have not been given the recognition due them. They have spent their time and money in developing a new means of power transmission offering possibilities without parallel. It is true that many installations have been made that were unsatisfactory, but in almost every instance it was due to poor analysis rather than poor hydraulic equipment. These failures, however, are far overshadowed by the great number of successful applications, and it is pleasing to note that the percentage of successful applications is increasing with the number of installations.

Flexible Shafting Many Extraordinary Drives

By Harold B. Veith

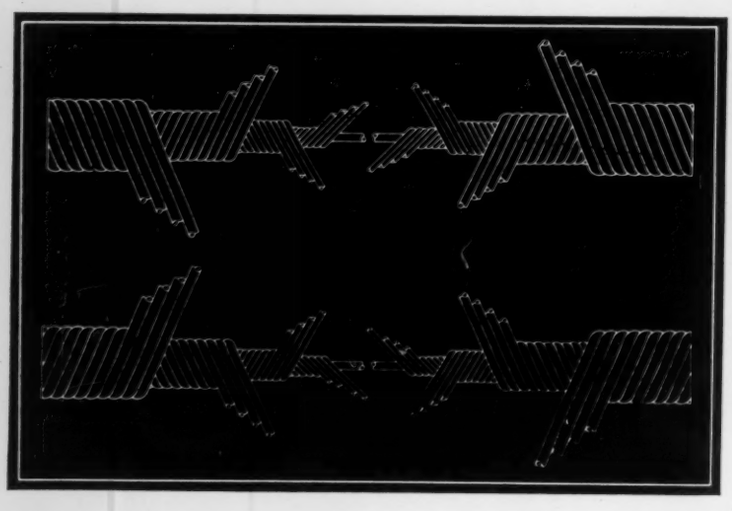
Editorial Representative, Machine Design

ALTHOUGH flexible shaft drives offer one of the simplest means of transmitting power between two points not in the same plane, their success is dependent on whether certain basic rules have been observed in laying out the applications. Radius of curvature, size, torque capacity at different speeds, all bear definite relation to each other and must be given close consideration. Other factors also arise which will be covered in the text following.

In this article only applications where the driving and driven centers are fixed will be treated. Typical of these are the yardage counter on a textile machine, Fig. 2, and the drive between a geared head motor and cutter bells on a cracker trimmer, Fig. 3.

An example of the use of flexible shafting to transmit motion to the contact mechanism of an oil burner control is shown in Fig. 7. The electrical circuit is opened and closed automatically by the shaft, one end of which is connected to a temperature controlled spiral coiled spring which is located in the furnace. At the other end of the shaft, connection is made with electrical contact units. When the spring becomes heated and expands it turns the shaft and closes the contacts and as the spring cools and subsequently contracts, the shaft is rotated in the opposite direction thus opening the contacts. A ¼-inch drive shaft in a ½-inch two wire metallic casing is used in this particular application. Ends are swaged to the shaft so that the arrangement will be impervious to heat. The shaft also is treated to prevent it from taking a permanent set during the summer when the device is idle.

Characteristics of an installation of flexible shafts to transmit power is the application depicted in Fig. 6. On this printing press two shafts are employed. Power is furnished by the one at the left to the mechanism which feeds the paper. Fingers which move the paper along get their power from the shaft at the right. In this instance the designer was able to solve a power transmission problem without having to incorporate a complicated driving arrangement. With this single, self-contained, easily attached unit, power is carried directly from one point to another. This particular application employs a ⅜-inch diameter shaft of high torsional strength. The casing is the two-wire metallic type.



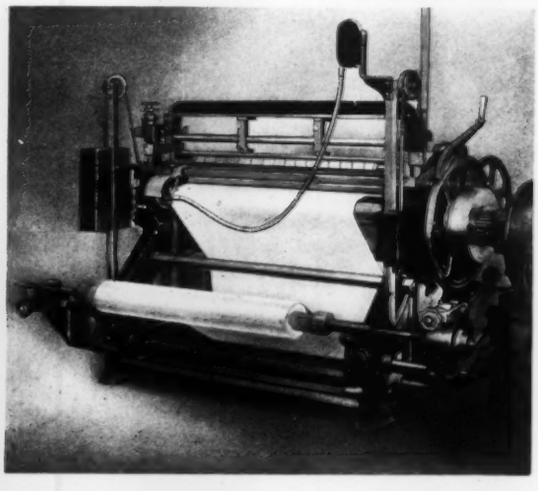


Fig. 1—(Left)—Flexible shaft construction showing how pitch of windings alternates and size of wire is graduated, increasing with each succeeding layer. Fig. 2—(Above)—Shaft provides a flexible drive for this yardage counter on a textile machine

Lends Itself to

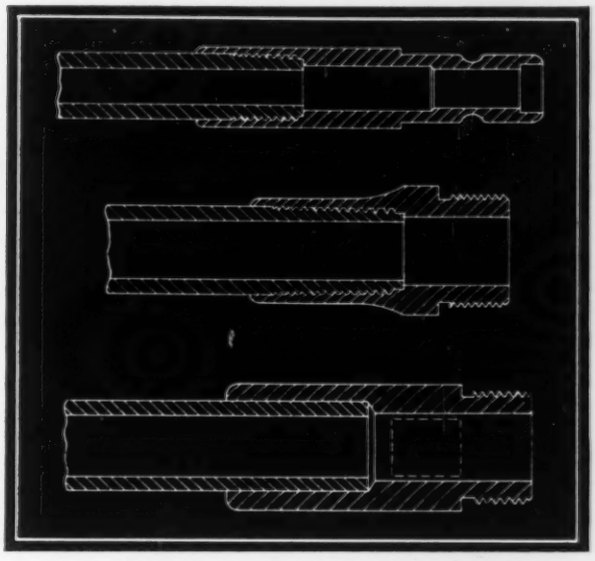


Fig. 4—Casing ends top and center views showing fittings attached to fabric casings. Connection to metallic casing is shown at bottom

In choosing a flexible shaft, size is one point on which a great deal impinges and when one larger than ¾-inch is required the question of economy arises. It should not be assumed that shafts larger than ¾-inch cannot be manufactured; the contrary is true, but factors enter into the design and construction of these larger shafts that have their effect on the cost. There are in use many successful and profitable applications of large units but it will be obvious that these constitute more or less a special problem. For this reason the following data will be devoted to sizes from .043 to .75-inch diameter.

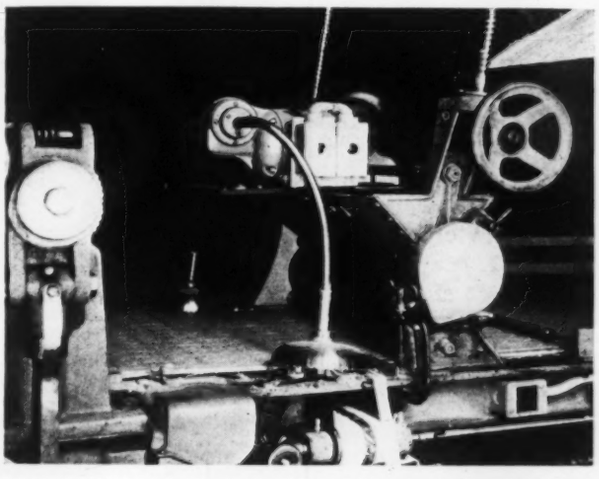


Fig. 3—Cutter bells on cracker trimmer driven by flexible shafts from a geared head motor

The desirable shaft possesses properties of torsional stiffness, transverse flexibility and facility for overcoming internal friction, all of which are balanced carefully. In other words, the shaft should offer maximum resistance to twisting under load with minimum resistance to bending and at the same time have as little internal friction as possible.

A complete flexible shaft assembly is comprised of four basic parts, namely the drive shaft proper, drive shaft ends, the casing and casing ends. Considering the drive shaft, the quality of which is one of the guiding factors in the success of an application, it is apparent that the material, winding process, and method of cutting and fastening the ends play an important role. A special grade of steel wire possessing high tensile strength and rigid specifications regarding uniformity is used.

Two or more superimposed layers of wire with or without a single strand of wire in the center are employed in the typical shaft. Each layer usually is wound with four strands. As illustrated in Fig. 1, the direction of the lead or pitch of the windings alternates, and the size of the wire generally is graduated, increasing with each succeeding layer.

Lay of a shaft is determined by the pitch direction of the outer layer of wires. A right-lay shaft is one in which the pitch direction of the outer layer is the same as that of a right hand screw thread; a left-lay shaft is the opposite. Fig. 1 shows the two types. If the right-lay shaft (top) is turned in a counterclockwise direction (assuming that the right hand end is attached to the driving source) the outer winding tends to tighten up. It is obvious, that a shaft will transmit its maximum capacity when rotation tends to tighten up the outer winding in this way, but if necessary the same shaft may be used with satisfactory results for driving in either direction. However, where a right-lay shaft is used for a left hand drive, or vice versa, or for a re-

TABLE I

Torque Capacities of Flexible Shafts

Grade of Shaft	Diam. of Shaft, in.	Safe torque capacities in pound-inches for straight and curved shafts. Radius of curvature in inches							Torsional deflection deg. per in. lb. per ft. of shaft
		Straight	20	15	10	8	7	6	5	4 (straight)
"H"	⅛	4.0	3.2	2.8	2.5	2.2	1.8	1.5	1.1	0.4	40.00
	¼	20.0	16.0	14.0	11.0	8.7	7.1	5.0	2.0	.....	2.30
	⅜	49.0	36.0	31.0	22.0	15.0	10.0	4.0	.....	.....	0.70
	½	78.0	53.0	44.0	27.0	14.0	5.0	.....	.....	.....	0.24
	⅝	112.0	70.0	55.0	28.0	6.5	.....	.....	.....	.....	0.11
	¾	152.0	86.0	60.0	28.0	.....	.....	.....	.....	.....	.....
"S"	⅛	2.3	2.0	1.8	1.7	1.5	1.4	1.2	1.0	0.5	45.00
	¼	11.0	9.0	8.4	7.1	6.1	5.4	4.5	3.2	1.3	2.90
	⅜	26.0	20.0	18.0	14.0	11.0	9.2	6.6	2.5	.....	1.60
	½	50.0	38.0	33.0	25.0	19.0	14.0	8.5	.....	.....	0.30
	⅝	75.0	54.0	47.0	34.0	23.0	16.0	6.3	.....	.....	0.16

versible drive, it is desirable to employ a larger size than would be required for driving in one direction only.

Drive shafts are manufactured in long sections which are subsequently cut to length to meet customers' requirements. Generally speaking, two means of securing the ends of shafts are used. Before cutting, the wires usually are secured at points where the cuts are made, to preserve the tension and prevent the shaft from unwinding. Brazing is commonly employed, but more recently there has been developed and patented a method which consists in compressing each end of the shaft in a die under a pressure of such magnitude that the individual wires are formed into practically one solid mass. Possibility of damaging the shaft by heat or of rusting which may result from an improper application of brazing is avoided by this process. The shaft readily can be cut or sheared after swaging.

Important points which should be considered in the selection of size and grade of shaft for a specific application are: Speed of rotation, power to be transmitted, length of shaft, curve or curves, direction of rotation, nature of driving and driven elements to which shaft is to be attached, and the type of service whether continuous or intermittent. Average applications are covered by these factors.

Selection of the proper grade of shaft comes before the specification of a particular size inasmuch as two grades of the same size will have different torque capacities. The grade depends on whether torsional strength or flexibility are major requirements. In the case of shafting manufactured by S. S. White Dental Mfg. Co., New York, grade H possesses high torsional strength or resistance to twisting strain and is adaptable to the majority of uses. Grade S shafting has greater flexibility than grade H and usually is employed where extreme flexibility is the governing factor.

Flexible shafting manufactured by Flexible Shafts, Inc., division of Stow Manufacturing Co. Inc., Binghamton, N. Y., is designated by three types, A, B, and C. The core of the type A is manufactured from high grade music wire. This also is true of type B which is recommended for use where torsional stiffness is a paramount consideration, such as in remote control applications. Type A is intended to withstand greater shock loads, and type C is recommended for comparatively light work only.

In selecting the proper size of shaft the torque or twisting force which the shaft must transmit is the principal deciding factor. This torque is established by the power to be transmitted and the speed at which the shaft is to operate. Torque in pound-inches which a shaft must carry for transmitting a given horsepower at a given speed is found from the following formulas:

$$\text{H.P.} = \frac{2\pi \times T \times N}{33{,}000}$$

Transposing:

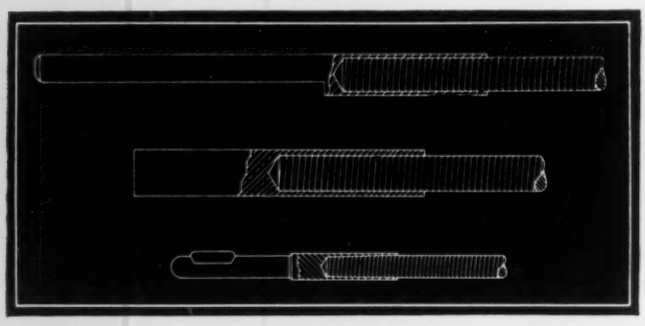
$$T = \frac{\text{H.P.} \times 33{,}000 \times 12}{2\pi \times N}$$

Where T = Torque in pound-inches;
N = Speed in revolutions per minute

Inasmuch as the torque decreases with increase in speed there is a distinct advantage in providing that the shaft run at the highest speed conditions will permit, thus enabling the smallest possible shaft to be used—often with reduced cost. After computing the torque in pound-inches, the next step in specifying shafts is to consult a table such as the one prepared by the S. S. White company and shown at the bottom of page 41.

Constants as follows have been worked out to simplify the application of the foregoing formula for various speeds.

Speed (R.P.M.)	Constant	Speed (R.P.M.)	Constant
500	.008	3500	.056
1000	.016	4000	.064
1500	.024	4500	.072
2000	.032	5000	.080
2500	.040	5500	.088
3000	.048	6000	.096



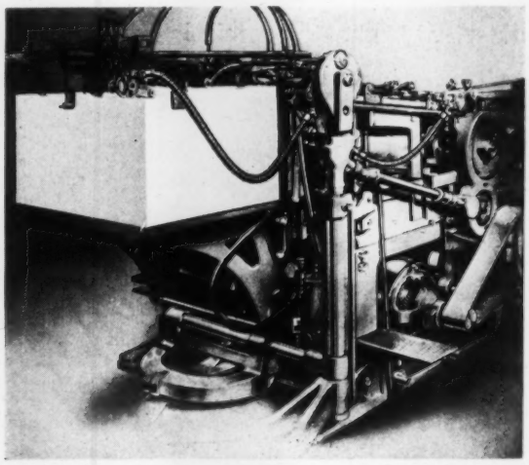


Fig. 5—(Above)—Three representative drive fittings attached to flexible shafts. Fig. 6—(Right)—Two shafts applied to printing press transmit power for operating paper feeding mechanisms

Fig. 7—Electrical contacts of oil burner control are opened and closed by flexible shaft

To find the horsepower which any shaft will transmit at a given speed, multiply its torque capacity as given in Table 1 by the constant for the particular speed. To find the torque in pound-inches which a shaft will have to carry when transmitting a given horsepower at a given speed, divide the horsepower by the constant for the particular speed. The size shaft that will be needed to carry this torque can be found by referring again to Table 1.

Speeds of 1750 to 3600 revolutions per minute are recommended as being suitable for operation of normal sizes of flexible shafts. However, these shafts place no limitations on design from the speed standpoint, inasmuch as they function efficiently at practically any speed when properly applied. For shafts larger than normal it generally is recommended that their speed should not exceed 500 surface feet per minute.

Referring to Table 1 it will be noted that torques given apply to both right-lay and left-lay shafts when rotating in one direction only, that is in the direction which tends to tighten the outer layer of wires. When operating in the opposite direction torque capacities are reduced from 20 to 50 per cent. Figures in the table are for shafts up to 25 feet in length. Beyond 25 feet, the weight of the shaft, its external friction and deflection under load are matters which may or may not make it impracticable to use a flexible shaft. In such special cases the manufacturer should be consulted.

As to lubrication, tests have revealed that smaller sizes of flexible shafts from 3/16-inch diameter down, under ordinary circumstances require little if any lubrication in operation. Lubrication, on the other hand, assists in preventing corrosion and in eliminating any slight noise which should be set up and, therefore, always is desirable. Shafts larger than 3/16-inch should be lubricated at regular intervals, the length of the period between them depending upon the nature of the application. When a shaft is running continuously or is in a curved position it should be lubricated more often than when service is less severe.

Lubricating the conventional shaft consists in removing the drive shaft from the casing, cleaning, and applying a light coating of grease.

Concurrent with the specification of proper size and length of shaft comes the choice of suitable drive shaft ends to engage the driving and driven members. These may be forked, splined, slotted, flat, square, threaded, or another of the multitude of different types available. Fig. 5 shows three shaft ends which are more or less representative of the type used in the average application. There are, however, hundreds of other kinds, their design depending almost entirely on the nature of the requirements. These ends, for the most part, are attached by the manufacturer, this being considered good practice. In many cases, however, shafts have been furnished plain, with the wires secured and tinned at the ends, ready for the customer to solder on his own driving ends.

Casings, likewise, are available in a number of different types and materials, including fabric and metallic, or rubber or leather covering on metal. An important point to watch in their selection is that they conform as nearly as possible to the flexibility of the shaft. These casings, like the drive shaft, have fittings which are connected to a fixed support. Three types are shown in Fig. 4. The top and center fittings are attached to fabric casings. A coarse tapered thread is shown for screwing the end fitting on to the fabric casing, with shellac for a binder. The unit at the bottom of the illustration is a standard metallic end which can be supplied to fit all sizes of metallic casings. These ends are attached by soldering or they can be swaged on, this usually being done in the smaller sizes. Another type of casing end, Fig. 8, employs the bayonet type of fastening. Pin A slips into slot B, and the ferrule is turned into place.

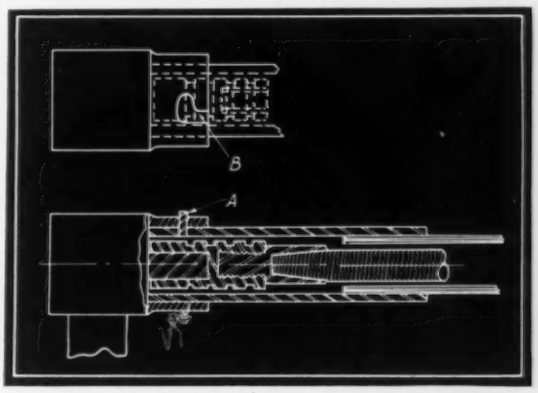


Fig. 8—Bayonet fastening holds casing end

Opportunity Awaits Those Who Can Carry Design Into New Channels

EVERYONE who has at heart the best interests of the design profession is urging engineers to broaden their perspective. The counsel to get away from the commonplace mathematical and slide rule complex has been voiced so often that the repetition probably is becoming tiresome.

It has remained for Walter Fishleigh, speaking before the Philadelphia section of the Society of Automotive Engineers, to approach the subject in a way that is bound to command the attention of thoughtful engineers.

"Engineers as a class," he declares, "are too serious, too careful, too cautious. . . . As engineers we try to reduce everything to third-decimal place analysis, whereas the greatest and most important problems are not susceptible to such analysis nor to exact solution. . . . In engineering, as in all other of the world's activities, a problem capable of exact and unquestioned answer, is a mighty small problem."

An engineer who restricts his activity to making determinations based on definite laws is doomed to a routine of mediocrity. Those in the design profession who want to forge ahead must display ability to deal with questions which involve a certain degree of speculation.

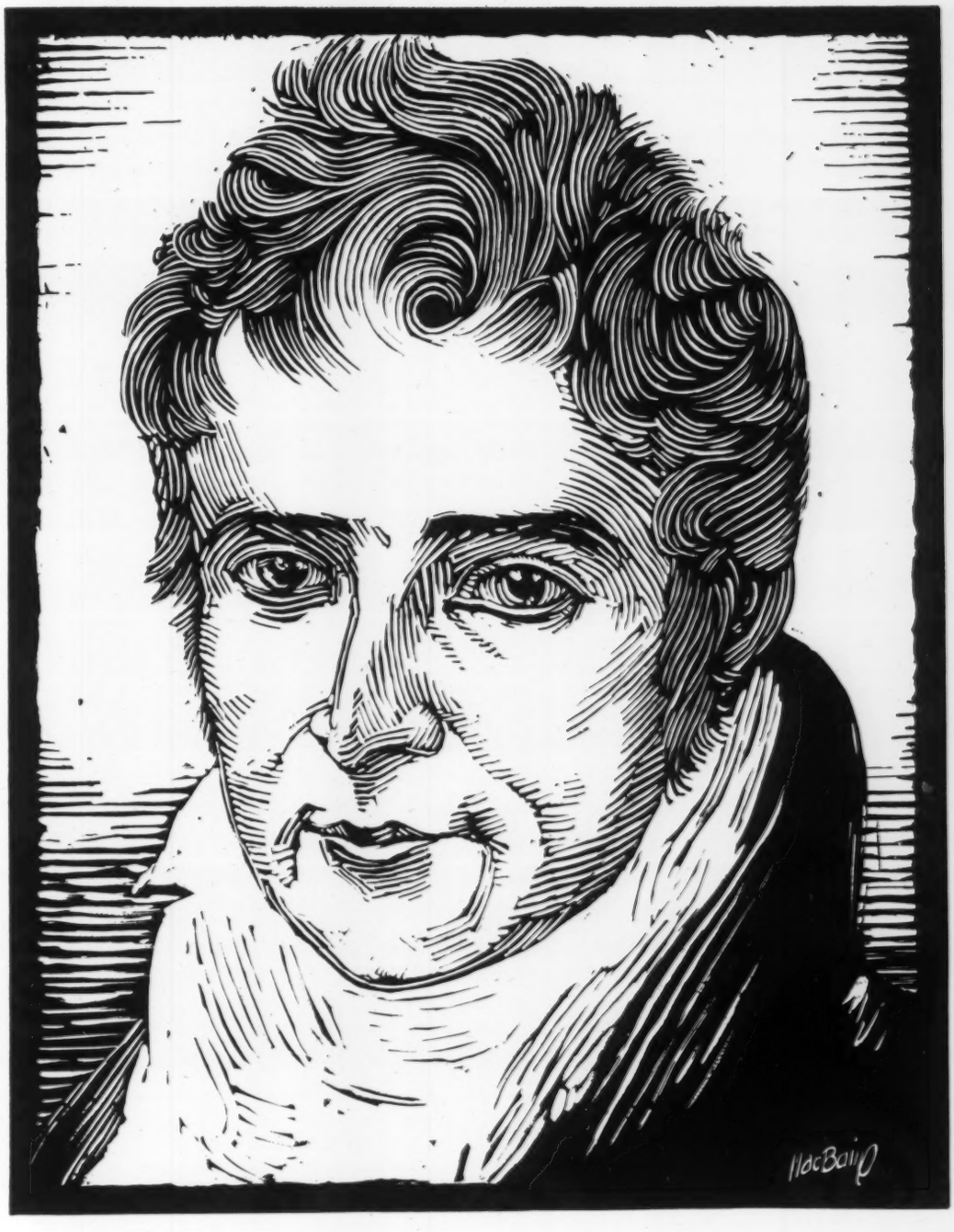
Industry can well afford to reward talent which will carry design and initiative and subordinate the impulse to drift along in the channel of tradition.

Determining Customer Needs

MARKET research, the importance of which was emphasized in this column several months ago, is receiving greater recognition among machinery manufacturers. Recently an investigator appearing before an assembly of mechanical engineers lamented the fact that in many cases the only sources of information on markets are conferences of executives, views of sales managers and suggestions from salesmen.

Obviously such methods cannot yield the desired data. Worthwhile market analysis involves contact with customers in a more methodical manner than through men whose chief aim is selling.

One company is organizing a consumer research department with investigators trained to study the problem from the viewpoint of design, production and distribution. For a company large enough to justify it, this seems to be the logical way to determine definitely what the customer needs.



Robert Fulton

Master Designers

Robert Fulton

ART and engineering, frequently considered irrelated professions, similarly require of their workers well developed imaginative and constructive abilities, so it is conceivable that the successful artist should prove to be an excellent designer. Leonardo, Morse, and Robert Fulton are three outstanding examples of artists who made important contributions to design. Fulton, born in 1765 in Pennsylvania, cannot be considered a true inventor; he was actually an adapter who took known ideas and welded them into usuable form. He was not the first to build a steamboat, but he was the first to build a practical commercial ship propelled in this manner.

FULTON'S work was marked by his methodical experimentation, intense enthusiasm and careful engineering calculations. He knew exactly the limitations of his devices, did not anticipate failure, and was rarely disappointed. His artistic works never received much prominence due to their neglect in favor of engineering topics, but his first successes were made in this field. His accomplishments include:

The first practical steamship
Mill for sawing marble or other stone
Lock system, a preponderating cistern of water
Digging machine for use on canals
Submersible boat for use in war
Naval torpedoes of various types
Proved that compass registered correctly under water
Proved that powder exploded under water

THESE and other commercial and military devices developed by Fulton were the basis for his receiving many awards and considerable honor. He built the first steam warship, established regular steamship service, and linked New York to New Jersey with steam ferry boats. Mistaken business judgment and violated patents limited the degree of his success, but this man, who as a boy never was interested in the usual school subjects, was able to build up a fortune and died at the age of fifty after providing the world with a vehicle that transformed history.

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments from Our Readers. Machine Design Will Pay for Letters Suitable for Publication

Finish Marks Need Modernizing

To the Editor:

THE article on this subject in the November issue of MACHINE DESIGN has aroused my interest considerably. When a workman has a diversified class of work to handle with little repetition it frequently is difficult for him to determine from the average blueprint the class of finish that is required. Conventional finish marks do not indicate anything beyond "finish" and "grind".

The machining symbols shown in the illustration accompanying your article quite clearly indicate just what is expected of the workman. There is no doubt that the use of this method would eliminate a lot of unnecessary supervision and more or less frequent rejects by the inspection department.

This method is not new, for it is used quite commonly in Germany as evidenced by various blueprints that have been received from that country within the last few months. It has, however, distinct merits that should be recognized.

—L. A. DEMKIER,
Dubuque, Iowa

EDITOR'S NOTE—Since the spotlight has been thrown on quality of machine finishes by the formation of a special committee of the American Standards association to investigate the advisability of the promulgation of standards of finish, it is anticipated that marks for indicating finish also will be given their share of consideration.

Improving the Engineers' Status

To the Editor:

IT WAS refreshing to read your editorial in the December, 1931 issue of MACHINE DESIGN wherein you again remind the engineering profession that they should interest themselves more in the commercial and managerial side of business than has been the case in the past. Altogether too often have engineering departments been looked upon as necessary evils, and in times such as we are now confronting, the first tendency of many managements is to reduce the personnel of such departments to a point whereby their creativeness is really destroyed because those remaining have their entire time occupied by routine work.

Possibly because of the difficulty in being able to evaluate the worth of an engineering department easily, as compared to a sales department, the average engineer does not receive the recognition he deserves. His designs often open up new markets, yet the salesman who brings in the order gets most of the credit and compensation.

Engineers undoubtedly will be among the leaders in lifting this world out of its present chaotic condition, but will they themselves really profit thereby to the extent to which they are entitled?

—C. E. SCHIRMER,
Springfield, O.

Advertisements Feature Design

To the Editor:

THOSE fellows who design machines are now supplying advertising men with a most progressive theme for their consumer copy. They are right in the advertising spotlight. Any number of advertisers are talking about them.

Manufacturers, always keen to discover new selling points for their merchandise, have hit upon the care, precision and originality that go into the designing and production of their goods as a feature worth elaborating on.

A notable example is the Elgin Watch Co. Several of its recent advertisements have made machines the burden of its appeal. "Only Elgin Machines Can Produce a Watch of Such Perfect Accuracy," is the headline of a page in the *Saturday Evening Post*. Another caption reads, "Human Error in Watchmaking Now Conquered by Amazing Machines."

Here are a few paragraphs of the copy that backs up these headlines:

> "This tells of watchmaking secrets no human eye or hand could ever learn! A story of ingenious machines . . . of marvelous mechanisms

. . . and how, after 66 years of development, they have captured the secret of unfailing accuracy in making Elgin Watches!

"It was years ago that Elgin's pioneers first conceived of these remarkable developments. Human skill, they knew, must always have its place—and a most important place—in watchmaking. Yet in certain vital operations no human eye or hand could ever achieve unfailing accuracy.

"Upon this revolutionary principle Elgin has perfected the most marvelous system of precision machinery the world has ever known. Machines that defy the eye and hand with their infinite exactness!

"Thus Elgin has mastered by machinery what man alone can really never do."

General Motors Radio Corp. follows the same theme in some of its advertising. For instance, under the display, "Only a radio exactingly built could bear the name General Motors," a telling point is made for the up-to-dateness of the design of its production equipment.

Of course, the Timken Roller Bearing Co. is probably the first concern to advertise machine design to Old John Consumer. For years it has been telling people that "Modern Industry Rolls on Timkens," or that "Timken Has a Bearing on Your Telephone," or has been tirelessly tossing other messages at the consumer to make him bearing-conscious. This advertising has made people appreciative of the value of roller bearings in products which they use, even though they, themselves, never have occasion to buy bearings directly. This consumer influence has been a mighty factor in getting manufacturers to equip their products with modern bearings.

The advertising of the technical processes of production to the public is a movement with which machine designers may well be in sympathy. Any publicity that gives people knowledge of the efficiency of modern manufacturing methods is likely to be valuable to the advertiser. After all, there is no better way to convince the public of the desirability of any merchandise than to dwell on the way that the producer designs and machines quality, utility, style and economy into that merchandise.

—JOHN ALLEN MURPHY,
New York

Salesmen Need Engineering Data

To the Editor:

YOUR articles in recent issues of MACHINE DESIGN entitled "Better Relations Between Engineers and Salesmen Needed" are well taken, and bear out my past experience in conference with the "Knights of the Brief Case."

On a recent job which required considerable research and experimentation, several conferences were held with sales engineers on pressed steel, platings and coatings, die castings and steel sheets. I was astounded at the insufficiency of the knowledge possessed by these men.

A representative of a pressed steel company was given a blueprint and asked for a price quotation. He couldn't even make a rough estimate either as to dies or cost per piece and promised to get a figure from his estimating department. About a month later he returned and stated that his company never made anything like the job before and then endeavored to sell me on the idea of using a standard design which they were making. I had to explain to him why his standard design would not do.

I called in an expert on hot tinning and asked whether he would guarantee his job; he couldn't, for he didn't know whether or not it would hold up under soap water. He said he had had 40 years experience in his line. Maybe he had but he wasn't up on his subject.

The die casting man was better versed on his costs but he knew nothing of salt spray tests or corrosion effects.

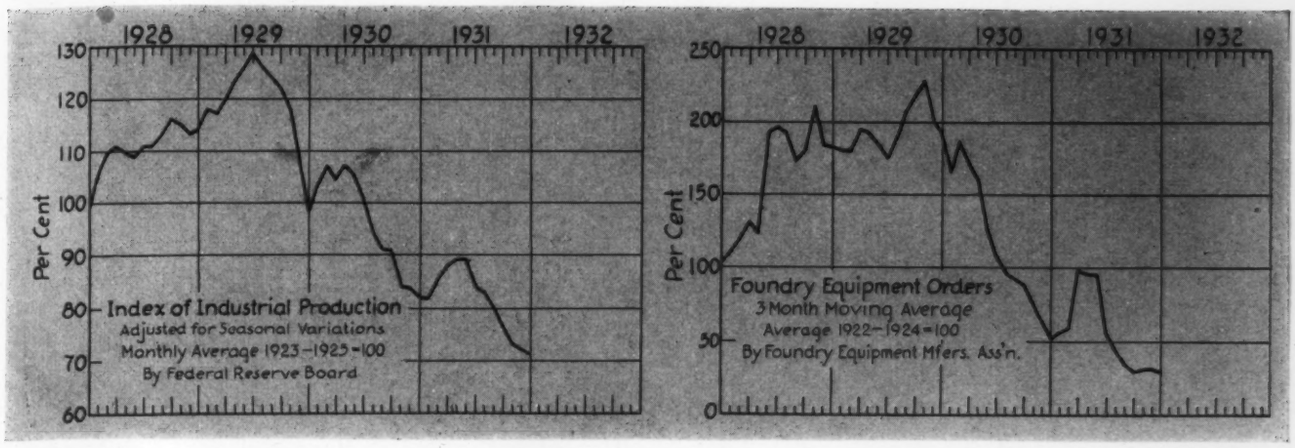
I don't entirely blame these men. The blame is on the sales managers or the business heads that send them out. They lay too much stress on the salesman's being a "Hail fellow well met" and forget that he should thoroughly know the part or material he is selling.

—JAMES M. MURPHY
Lakewood, O.

Determines Belt Transmissive Power

INVESTIGATIONS made of the transmissive power of oak-tanned leather belts and rubber belts on cast iron and paper pulleys are recorded in "Belt Drives with Cast-Iron and with Paper Pulleys," by C. A. Norman and G. N. Moffat, department of mechanical engineering, Ohio State university. This report, published as bulletin 62 of the University Engineering Experiment station, gives the transmissive power of these various combinations, particularly at small angles of contact. It was found that paper pulleys give excellent transmissive power with both kinds of belts, but that they were particularly effective in improving that of rubber belts. The bulletin may be obtained from the University at Columbus, O., for 25 cents.

IN CONNECTION with Fig. 2 of the article on "Developing Combined Translatory and Rotary Motion," by William A. Rosenberger, in the January issue of MACHINE DESIGN, if flat faced rollers or wheels are used, three of them must be employed in order to avoid stationary or semi-stationary work-guides which would introduce undesirable frictional resistance. Due to an error the author's text was incorrectly printed in the original article.

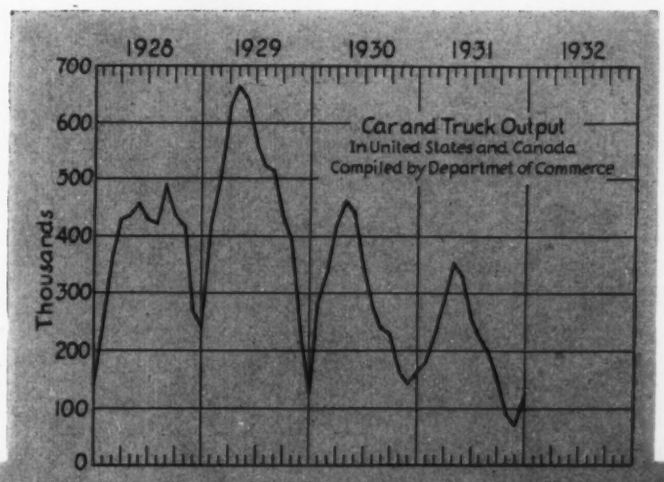


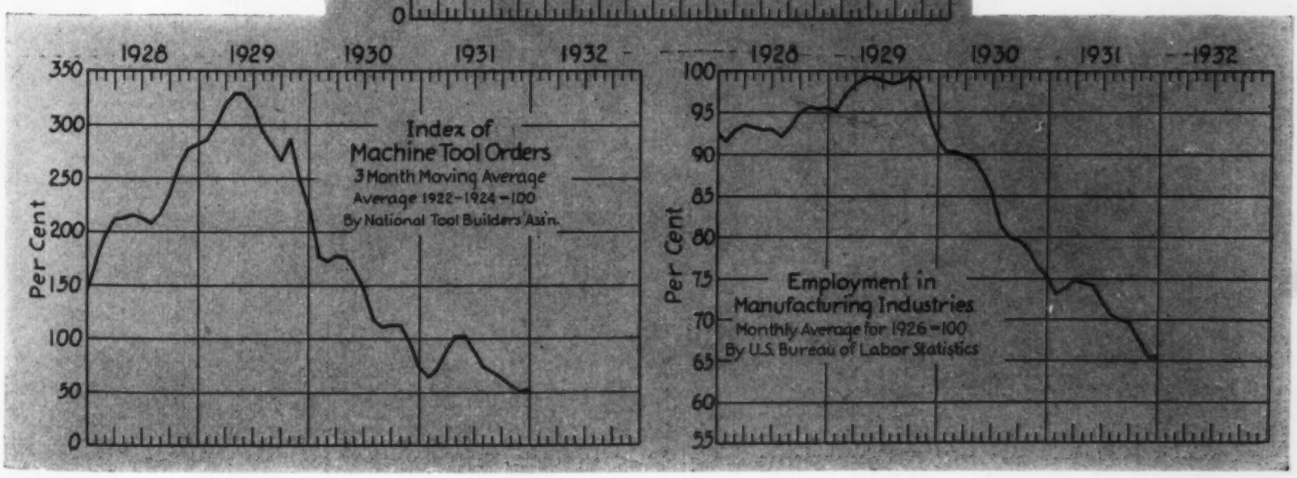
How Is Business?

ONE of the biggest factors in the long downward slide was the extreme inactivity experienced by the automobile industry. This group has brought out vastly improved designs and has stabilized itself to such an extent that it now displays one of the best futures visible on the otherwise murky business horizon.

The first symptoms of recovery in this giant consumer of materials, parts and machines was evidenced at the recent New York show where attendance ran 25 per cent ahead of 1930 and actual sales over five times ahead. A great potential market exists for automobiles. Cars less than one year old in use at the end of 1931 were 50 per cent fewer than in 1929. During the same period the number of cars over 5 years old increased over 120,000, while the total cars in use decreased 850,000.

Retooling to produce the new models has already been reflected in the machine tool industry where the index of orders turned upwards for the first time since May. Industrial production and employment in manufacturing industries did not advance, but both decreased their losses very considerably. An advantage of the declines from the standpoint of the statistician is that the trend lines for the past three years can all be plotted on the same yearly chart, each fitting neatly beneath the previous curve. Only when these lines stop being docile and cut upwards through the previous trends will definite recovery be recognized. Such a contingency is becoming increasingly probable during the reconstruction.





MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

IN NOMINATING H. P. Charlesworth its next president, the American Institute of Electrical Engineers chooses an engineer who has been associated with the telephone industry since 1905, the year he was graduated from Massachusetts Institute of Technology. He now is 49 years old, having been born April 7, 1882, in Haverhill, Mass. Entering the engineering department of the American Telephone & Telegraph Co., then located in Boston, his early assignments covered the development of telephone circuits and associated apparatus. Later he was active for a number of years in the development of toll operating methods and related engineering problems.

During the World war he was assigned to handle problems wherein the Bell system could be of assistance to the government. Shortly after the close of the conflict he became for a short time equipment and transmission engineer of A. T. & T., and in 1920 was appointed plant engineer of the company. In December, 1928, Mr. Charlesworth was elected vice president of Bell Telephone laboratories, where he now directs operations involving more than 5000 people engaged in development, research and related activities.

Mr. Charlesworth became a member of the American Institute of Electrical Engineers in 1922 and a fellow in 1928.

DILIGENCE and unusual technical acumen carried W. C. Heath from Capron, Ill., a crossroads town in the corn belt of northern Illinois, where he was born in 1887, to his recent appointment as vice president in charge of research engineering and plant production of the A. O. Smith Corp., Milwaukee.

Early in life Mr. Heath displayed an intense interest in engineering and mechanics. He attended the University of Wisconsin in 1907 and afterwards Lewis institute in Chicago in quest of technical training. Then he became a draftsman in the engineering department of Fairbanks, Morse & Co., Beloit, Wis., in 1909. During the period Mr. Heath was with that company it advanced to become a leading manufacturer of diesel engines, pumps and power house equipment. Even today in Beloit, Mr. Heath has the reputation of being a "bug for research and development."

In 1919 he was made superintendent of the Beloit works and in 1920, general manager. Six years later the other plants of this company in Three Rivers, Wis., Michigan and Indianapolis, now consolidated in Beloit, were placed under his management. The title of vice president in charge of all manufacturing was bestowed upon him in 1927, he having retained this position until his recent affiliation with the A. O. Smith Corp.

WORD comes from Schenectady that Everett S. Lee, assistant engineer of the general engineering laboratory of the General Electric Co., has been appointed engineer of the laboratory to succeed the late Louis T. Robinson. Simultaneous with this appointment is that of Dr. J. J. Smith to succeed Mr. Lee as one of the assistant engineers.

Mr. Lee was graduated from the University of Illinois in 1913 with the degree of B. S. in electrical engineering and in 1915 Union college awarded him the degree of master of science. He entered the test department at the General Electric company in 1913 and then went to Union college as an instructor in electrical engineering. Following the World war, in which he held a commission as first lieutenant, Mr. Lee entered the general engineering laboratory of the company, and in 1928 was made an assistant engineer of the laboratory.

Mr. Lee formerly was chairman of the Schenectady section of the American Institute of Electrical Engineers, and at present is a member of two national committees of the institute. He is chairman of the sections committee, and a member of the instruments and measurements committee. Other affiliations include Tau Beta Pi, Eta Kappa Nu and Sigma Xi, honorary engineering and scientific societies.

JOINING the staff of the International Nickel Co. Inc. in 1922, Thomas H. Wickenden has risen in this brief span to assistant manager of the development and research department of the

Leaders in Design, Engineering and Research

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organization. It is his technical background that has assisted Mr. Wickenden most. Born in Toledo., O., he obtained his collegiate education at Denison and the University of Michigan.

After his graduation Mr. Wickenden became affiliated with the Studebaker Corp. as a metallurgist, later entering the engineering department where he had charge of its activities as well as those of the laboratories at the South Bend plant. His design work here not only applied to automobiles but also extended into the field of road oilers and street flushers which were being manufactured by the company at that time.

Leaving Studebaker he was connected with the Zeder, Skelton, Breer engineering organization and was active in the design and material specifications of the first Chrysler car. Initial duties with the International Nickel Co. placed him in charge of development in the aviation and automotive industries. His work has consisted in the promotion of various nickel products such as steel, cast iron and other alloys in these industries and the solution of many problems requiring careful engineering analysis as well as metallurgical knowledge.

Mr. Wickenden has been active in publishing technical papers in his field and is a member of several of the leading engineering societies.

* * *

H. W. Risteen, recently was appointed assistant professor of mechanical engineering at Michigan College of Mining and Technology, Houghton, Mich. Prof. Risteen has served in the aeronautical testing division of the naval aircraft factory at Philadelphia, and as an experimental engineer with the Comet Engine Corp., Madison, Wis.

* * *

Charles B. Jahnke has resigned as director of engineering of Fairbanks, Morse & Co., Beloit, Wis. Mr. Jahnke is especially known for his development of diesel engine design.

* * *

Albert H. Myers, who was for several years executive engineer of Wellman Engineering Co., Cleveland, has established a literature research service for engineers and patent attorneys. His headquarters are at Milwaukee.

* * *

John V. N. Dorr, president of the Dorr Co., New York, has been elected president of the American Institute of Chemical Engineers for the coming year. He has received numerous previous honors for his early work on chemical engineering equipment of which his present company has been the outcome.

Herbert S. Whiton has been appointed chief mechanical engineer, Byllesby Engineering & Management Corp., Chicago, succeeding H. Boyd Brydon, who retired last year. Mr. Whiton has been connected with the Byllesby company since 1923.

* * *

G. B. Warren has been appointed designing engineer of the steam turbine section, and M. A. Savage designing engineer of the steam turbine generator section, of the General Electric Co., Schenectady, N. Y. J. H. Doran is the new assistant on mechanical design for the turbine engineering department.

* * *

Carl A. Peterson, formerly designing engineer for the Atwood-Bradshaw Corp., Pittsburgh, has been made chief engineer and a director of the company. Ralph N. Robertson, who recently resigned as chief mechanical engineer of the Blaw-Knox Co., Pittsburgh, to join the Atwood-Bradshaw Corp., has just been appointed vice-president and a director of the Atwood-Bradshaw concern.

* * *

Tillman D. Lynch, manager of the materials and process engineering department, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has resigned, and plans to engage in the business of consultant on materials and design in Pittsburgh. Mr. Lynch was president of the American Society for Steel Treating in 1923, and also is a former president of the American Society for Testing Materials.

* * *

E. L. Lasier, consulting materials and industrial engineer, Palisades, N. J., has been appointed chairman of a committee to review the eligible technical papers presented at the annual meeting of the American Society for Testing Materials last June in order to select the author who is to receive the Dudley medal at the next annual meeting. J. B. Johnson, chief, materials section, materiel division, Wright Field, Dayton, O., and J. C. Pearson, director of research, Portland Cement Co., Allentown, Pa., also are members.

* * *

Prof. Kalman J. De Juhasz, of the experiment station at Pennsylvania State college, is the recipient of the Rudolph Diesel Award for 1931 for his paper entitled "Dispersion of Sprays in Solid Injection Oil Engines," which was selected by the board of award as the best paper presented at the national meeting of the Oil and Gas Power division of the American Society of Mechanical

(*Concluded on Page* 74)

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

THE United States patent office passed on 20,128 more applications last year than it received, accomplishing 14 months work in 12; and thus reducing an average of two months the time an inventor had to wait for official action on his application for patent, according to the department of commerce.

Commissioner Thomas E. Robertson attributes this accomplishment to an increase in the staff of his organization a year and a half ago and also to the introduction of a new supervising system that makes for accuracy and better handling of applications. Last year applications numbered 79,513 against 89,397 in 1930 when a record for any single calendar year was established, these figures including only new patents. On Dec. 31, 1931, there were pending applications for 90,274 in the Washington office.

* * *

Fifteen Million Volt Generator Is Planned

MORE than 15,000,000 volts are expected to be delivered by a new generator developed by Dr. Robert J. Van de Graaf, a young physicist holding a National Research fellowship at Princeton university. He recently exhibited a model generator delivering one-tenth as much power before the American Institute of Physics in New York. The larger machine will be constructed under the auspices of the Massachusetts Institute of Technology.

* * *

Diesel Truck Sets New Nonstop Record

CONCURRENT with the development of the Stearns 8-cylinder diesel described on page 25 of this issue, is the completion of a 14,600 mile nonstop record set up recently by a diesel-equipped truck on the Indianapolis speedway. C. L. Cummins, pioneer designer of automotive diesels is holder of the new world's record, during the establishing of which an average speed of 43.41 miles per hours was maintained.

The diesel three-ton truck exceeded the previous mark set on the speedway by a Roosevelt sedan by 64 miles, the record having required only 308 hours and 30 minutes. Another important feature of the test was that the engine ran for 10,005 miles on the initial fuel supply carried aboard the truck at the beginning of the test. Extra fuel was taken on twice to continue the run to the nonstop record. Unofficial fuel mileage for the distance of 10,005 miles was announced as 11.012 miles a gallon, 908.5 gallons having been consumed. Average for the entire run was 10 miles on a gallon.

C. L. Cummins participated in the driving. He plans to take the truck on an exhibition tour after the motor is checked and adjusted at the Cummins Engine Co., Columbus, Ind. Immediate plans, he stated, call for the production of 25 motors of the type used in the test to be placed in service with truck operators in all sections of the country for a final service test.

* * *

New Speedboat, "Miss England III," Ordered

TO REPLACE its sister craft which met with disaster in the Detroit river last year, a new speedboat, Miss England III has been ordered designed and built by Lord Wakefield. Thornycrofts will execute the plans and construction at their riverside plant on the Thames, near London. The boat will be fitted with two 1932 Schneider seaplane type Rolls-Royce engines, 2500 horsepower each, the makers of which will co-operate with Thornycrofts in the design of the hull. Twin screws will be employed.

Exhaustive tank tests are to be undertaken as a preliminary. Kaye Don will pilot the craft next year in attempts to improve the recent world's speed record made by Gar Wood. Mr. Don also will compete in the races for the D'Annunzio trophy on Lake Garda in Italy and the Harmsworth trophy in the United States. The design of the new craft is said to differ radically from its sister ship.

* * *

Welding, Torch Cutting Find Wider Use

STEEL sheets, cut with a torch and welded into the finished machine, are being employed by still another industry, the road machinery manufacturers, as indicated by the latest designs shown at the exhibition of the American Road Builders association, Detroit, and at the exhibition of road machinery held by Cleveland Tractor Co., Cleveland. This trend in design, which has gained considerable prominence within the last year, is now applied to machinery that receives violent shocks different from those previously

encountered. The welded designs are built up entirely from standard shapes and torch cut sheets.

* * *

Vote Against the Shackling of Machines

NEW ENGLAND executives, canvassed by the New England council on the matter of increasing employment by restricting the use of machinery, voted 545 to 71 against such a plan. Strong opposition to compulsory employment insurance was expressed. Reserves to help maintain the income of stable industrial forces during slack times were favored by 323 New England executives and opposed by 207.

Increased research for new products and improvement, new machinery of higher capacity, new manufacturing processes and revision of manufacturing layout are policies which members of the New England council plan to further this year.

* * *

Prominent Engineer Makes Predictions

A GASOLINELESS, waterless car propelled by radiated electricity and many other improvements that are likely to be incorporated in the automobiles of a few years hence were predicted by T. J. Litle, Jr., engineer and industrialist of Detroit and Dayton, speaking before the Society of Automotive Engineers recently. He declared that we have been slaves to tradition. He decried engineers who copy rather than create. Drawing a parallel with the railroad which he believes is equally antiquated in its methods of design, he said it only has remained for some engineer to stick the exhaust pipe up where the radiator cap now is to complete the ridiculous picture. Both railway and automobile engineers still persist in placing the powerplant with its heat and fumes ahead of the passengers.

* * *

Designer and Foundry Must Co-operate

SUCCESS or failure in producing aluminum alloy castings, or, in fact, castings in any metal, begins on the designer's drawing board. The success or failure is measured by the ultimate quality of the castings and the cost of their production. This was the opening statement of H. J. Rowe, Aluminum Co. of America, in his paper presented at the recent meeting sponsored by the American Foundrymen's association and the Philadelphia Foundrymen's association at Philadelphia.

It is true, of course, that the foundry plays an important part in this success or failure through their foundry technique. However, in many cases the design so limits the foundry in the use of the desired technique that inferior castings are the inevitable result. In many cases the engineer or designer may be able to achieve the desired ultimate result through several different casting designs. Of these designs there is generally one that is better suited to good foundry practice than are the others.

If the designer is familiar with those factors which make for the best foundry practice, he has little difficulty in submitting the most desirable design to the foundry. If the designer lacks this information, and later, when informed of possible casting difficulties, cannot make the design changes suggested by the foundry, he may have to be satisfied with inferior castings not produced in the most economical way. Such conditions can only be overcome by close co-operation between the engineer, the designer, and the foundry, Mr. Rowe explained.

* * *

Air Conditioning Undergoes Development

MACHINES embodying refinements in design have made possible increased development in air conditioning for homes, factories that require close control of atmosphere, as well as auditoriums, theaters, hotels and other large meeting places, it was revealed by industrial equipment exhibited at the Second International Heating and Ventilating exposition held in Cleveland, Jan. 25-29. This exposition was arranged in conjunction with the thirty-eighth annual meeting of the American Society of Heating and Ventilating Engineers.

More than 225 exhibitors displayed equipment, much of which was intended for domestic rather than industrial use. The observer was impressed with the growing employment of rolled steel products in the manufacture of equipment and the larger application of welding as a fabrication method. The exhibits also were indicative of a trend toward equipment to be employed throughout all seasons, heating in winter and cooling in summer.

* * *

Machinery Reduces Farm Production Costs

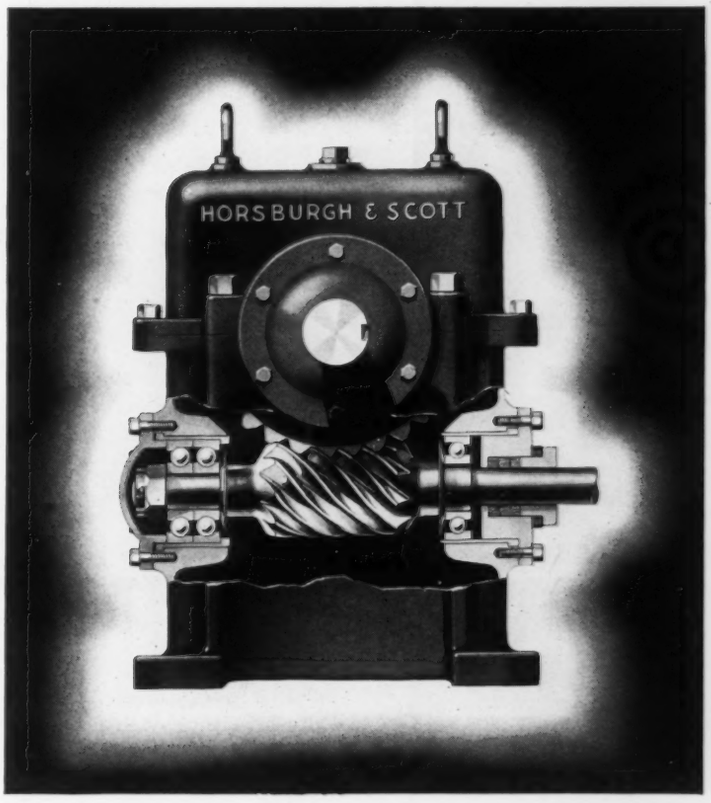
MECHANIZATION is continuing to reduce costs of production in agriculture, Secretary of Agriculture Hyde declared in his report to President Hoover.

With modern power machinery in the cotton belt only 30 to 35 hours of man labor are required to grow an acre of cotton, ready to pick, compared with 80 hours under the old 1 or 2 mule-system. As to making hay, one man with a tractor-drawn mower and side delivery rake, covers 25 acres a day—50 times the area one man could cut and rake a century ago. The secretary sees no menace to the family-sized farm in this progress of mechanization; rather, by enabling the family labor supply to cover more land, such equipment "tends to conserve rather than destroy the family-farm system."

GURNEY BALL BEARINGS

Maintain Initial High Efficiency In

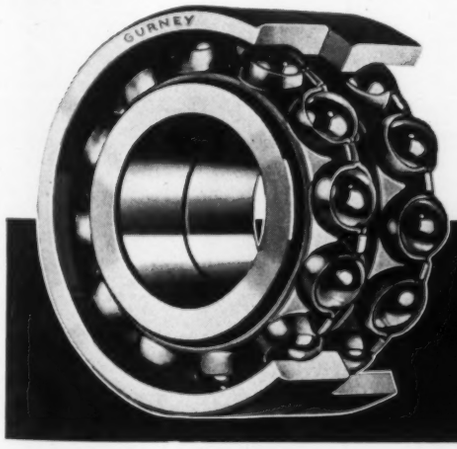
Horsburgh & Scott Speed Reducers



• HORSBURGH & SCOTT Speed Reducers are known for their extreme simplicity; compactness; smooth, even transmission of power. The worm shafts of these units are mounted on Gurney Ball Bearings . . . a Gurney Duplex at the closed end, a husky single row Gurney at the drive end.

The Gurney Duplex is assembled with a slight preload to take up all bearing looseness. This bearing is an exceptionally efficient thrust carrier — gives accurate and rigid shaft support for the worm—does not wear with usage or lose its support efficiency. The Gurney single row locates the shaft radially, keeping it in proper mesh with the worm.

• GURNEY BALL BEARINGS have been used in Horsburgh & Scott Speed Reducers for many years—demonstrating their ability to maintain initial efficiency —without wear—loss of accuracy—or adjustments . . .



GURNEY BALL BEARING DIVISION
MARLIN-ROCKWELL CORPORATION
JAMESTOWN, N. Y.

GURNEY BALL BEARINGS

NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

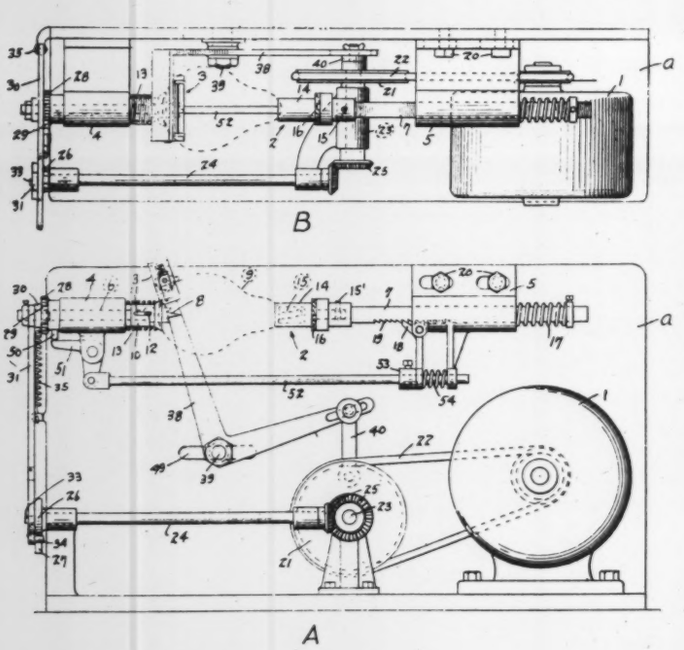
SEVERAL unique ideas are embodied in a fruit peeling machine for which a patent recently was granted to Maurice Reinstein and Edward Erikson, San Francisco. The invention provides a unit for peeling pears, incorporating a device for moving a knife longitudinally across the surface of the fruit to cut skin deep regardless of the contour, intermittently turning it, and ejecting the peeled fruit at the completion of the operation.

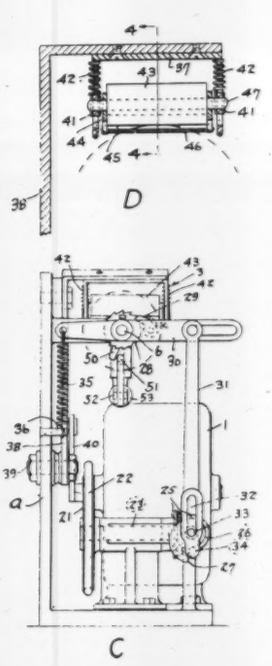
As shown in Fig. 1, *A*, a spring 13 forces member 10 toward the right and causes it to bear against the pear to hold it in suspension between prong 8 and cup 14 which receives the stem end.

In operation the pear is rotated intermittently through a number of small arcs until it has been turned completely through one revolution. Rotation of shaft 24 will drive cam 26 in a clockwise direction and will slowly move link 31 downwardly (*C*, Fig. 1) until pin 34 reaches the step 27. During this movement pawl 29 is moved idly over ratchet 28, placing spring 35 under tension, the spring having its ends connected to arm 30 and to a projection 36 carried by frame *a*. When the pin 34 is released by the step 27, the arm 30 will be quickly swung by spring 35, and pawl 29 will engage with ratchet 28 for quickly swinging the pear through a small arc. This swinging of the fruit is to bring the unpeeled portion into a position where the knife can traverse it.

Views *D* and *E* depict how the knife frame 37 is carried by a bell crank lever 38, and *B* shows how the bell crank lever is pivotally and adjustably secured to frame *a* at 39, and is connected by a link 40 to the eccentric 21. A cutting knife 46 having two cutting edges, is carried by carriage 44, and adapted to oscillate about shaft 47 as a pivot. Springs 42 keep the three rollers, 43, 44 and 45 contacting with the surface 48 of the fruit, regardless of its curvature. These rollers determine the depth which knife 46 enters the fruit and this depth may be adjusted so that only the skin will be removed.

The mechanism for automatically releasing the fruit after it has been entirely peeled, is shown in Fig. 1, *A* and *C*. Shaft 6 carries finger 50 which engages with a trip 51 after the shaft has made its complete revolution. Trip 51 moves rod 52 (see *A*) and the rod carries a collar 53 that moves pawl 18 into released position when trip 51 is actuated. Freeing of pawl 18 permits spring 17 to move cup 14 away from the fruit. This permits member 10 to eject the fruit from





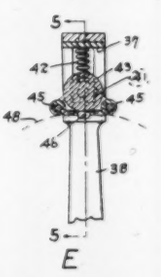
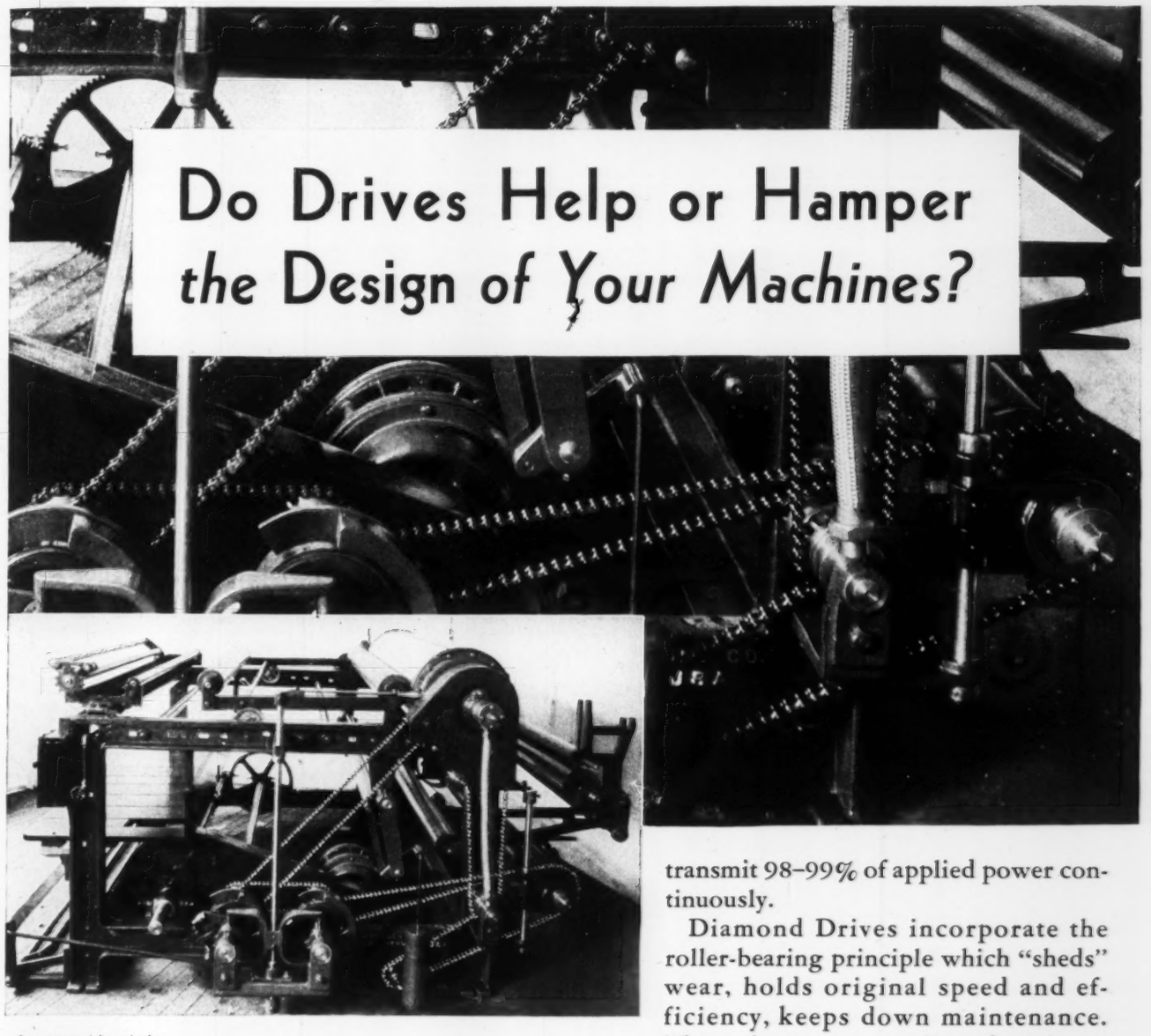


Fig. 1—Pear peeling machine employing a knife which moves longitudinally across fruit to cut skin deep regardless of contour. At the completion of the operation the peeled fruit is ejected

Do Drives Help or Hamper the Design of Your Machines?



An example of the flexibility of Diamond Roller Chain Drives—a Decatur machine manufactured by the Parks & Woolson Mfg. Co., Springfield, Vt.

"IT belongs there, but we can't drive it there"—too often the limitations of drives force this compromise in arranging units of a machine. But by standardizing on Diamond Roller Chain Drives, logic, not necessity, can rule design.

Diamond Roller Chain Drives are flexible, can be run *over* or *under* any number of sprockets—and on short or long centers. They are compact and light in weight for their capacity and transmit 98–99% of applied power continuously.

Diamond Drives incorporate the roller-bearing principle which "sheds" wear, holds original speed and efficiency, keeps down maintenance. Thus, the most complicated main or auxiliary,—slow or high speed drive problem is quickly solved by the decision to use Diamond.

The 8 classes of applications on which Diamond Roller Chain Drives serve better are described in the Booklet 104-B *"Simplifying and Improving Machine Design."* Mail the coupon.

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(A-4165)

prong 8. Spring 54 returns the rod 52 to normal position and causes pawl 18 to engage with rack 7.

The patent, of which American Machine & Mfg. Co., San Francisco, is assignee, has been designated 1,837,335.

BECAUSE of the increased application of coin control mechanisms, the invention of a new unit by Kenly C. Bugg for Ozark Novelty Co., Farmington, Mo., is particularly timely. Patent No. 1,839,736 has been granted the device by the patent office. A principal feature is the arrangement for separating slugs from coins and preventing control of the mechanism by such slugs. The assumption is made that spurious slugs are in most cases lighter in weight than the coin.

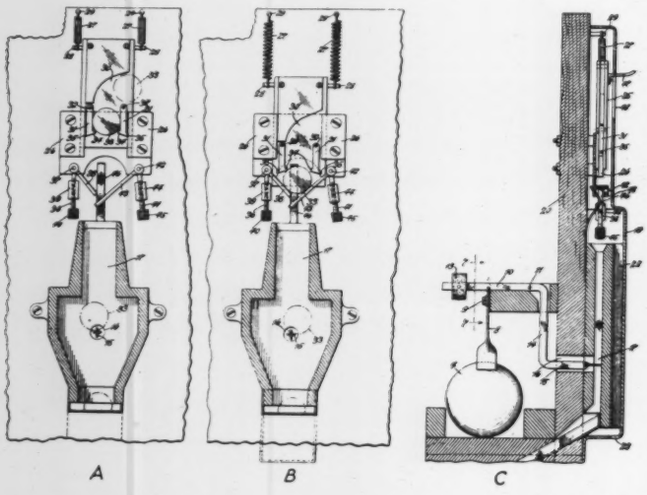

Fig. 2—Coin control mechanism which ejects spurious slugs

Fig. 2, *A* and *B*, show the parts of the device in unoperated and operated positions, respectively. A vertical sectional view of the device is shown at *C*. The coin receiving and assorting device is mounted for vertical sliding movement between guides 26 and is supported by springs 27. It is necessary to move the device downward so that arms 35 are below the lower ends of guides 26 in order to permit arms 31 to be moved apart by coin 33 to pass between projections 34 and drop.

The coin selector and slug ejector mechanism is located above chute 17 so that the coins and slugs dropping from the receiving and assorting device fall on the selecting and ejecting mechanism. Coin 33 coming from the coin receiving arrangement drops on to or against arm 38. Arm 38 is threaded and has a counterbalance nut 39 on it which may be adjusted by its screw connection in order to provide for the operation of arm 38 by a coin of approximately true weight.

A leaf spring having a portion 46 curving outwardly into the vertical plane between chutes 17 and 30 comprises the slug ejector. When the coin receiving device 25, *C*, is moved downward the rear wall presses against and bends spring 46 to a position out of alignment with chutes 30 and 17 so that at the proper time the coin or slug contained in chute 30 will push arms 31 apart and drop on to arms 38 and 43. If this coin is of true weight, it will press arms 38 and 43 apart and drop into chute 17 and thence on to the end 15 of latch 10 from lever 8, permitting the apparatus to function. If a spurious slug is inserted into chute 30 and discharged on to arms 38 and 43, it will not operate the arms but will be supported thereby and held from passing into chute 17. When the coin receiving device rises it moves out of engagement with curved spring 46 which immediately acts to throw the spurious slug into chute 22.

AN ARRANGEMENT for mounting a sprocket on a shaft with capacity for universal movement between the sprocket and the shaft is embodied in a new device designed by Floyd E. Davis, Allentown, Pa. Patent No. 1,836,706 has been granted the invention, of which International Motor Co., New York, is assignee. The face of the sprocket and its universal mounting, partly broken away for details, are shown in Fig. 3, *A*. Sectional view is given at *B*.

Means for mounting the sprocket *a* on the hollow jackshaft *b* comprise an annular-shaped piece *c*, formed to receive two diametrically located bushings c^1 in which short trunnions c^2 are journaled. The sprocket is carried with the annular part *c* by means of the diametrically extending trunnions c^2 and thereby is enabled to turn about its vertical diameter. The part *c*, in turn, is carried with a second annular piece *d* by means of bushings d^1 and diametrically extending trunnions d^2 at 90 degrees from trunnions c^2, so that part *c* is capable of rotation about the horizontal diameter of *A*, Fig. 3.

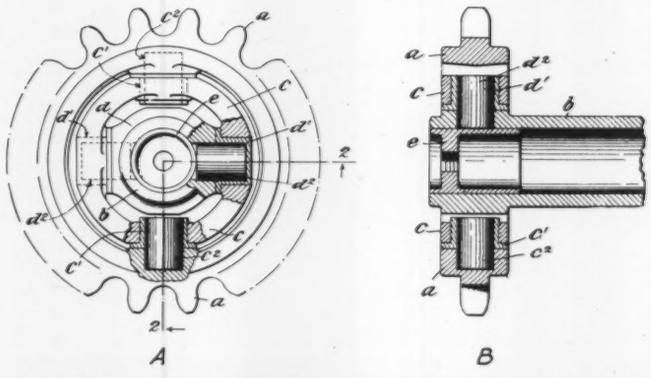

Fig. 3—Universal mounting of sprocket prevents chain twisting when misalignment occurs

Trunnions d^2 are retained in place by part *e* which fits within the hollow jackshaft *b*. Thus as the shaft turns, the sprocket is capable of universal movement with respect to it. Application of this part pertains particularly to vehicles which are driven over rough roads.

MOLDER AND ASSEMBLER OF PLASTIC PRODUCTS GAIN PRODUCTION SPEED AND ECONOMY BY MAKING FASTENINGS WITH SELF-TAPPING SCREWS

Used to advantage on scores of plastic products

A letter from a manufacturer who uses Self-tapping Screws for assembling products made of celluloid, Karolith and casein says: "Self-tapping Screws save us about 25 per cent on assemblies formerly made with wood screws, rivets and machine screws in tapped holes. They have speeded-up production, make better and safer fastenings, smoothed out assembly troubles, and minimized repairs on returned merchandise."

Another report comes from a Molder of Bakelite: "By eliminating all inserts, we not only saved the cost of the inserts which alone are more costly than Self-tapping Screws—but we were able to speed up production in our molding over 30 per cent. In our assembly department we increased production by 100 per cent."

The illustration indicates the wide variety of products which are molded or assembled better and more economically with Self-tapping Screws. And the applications are rapidly growing. Molders are recommending these unique Screws to their customers as a means of reducing costs, without sacrificing quality. Manufacturers who assemble molded, cast, and laminated plastic products see the advantages of the Screws, and use them wherever practicable.

What would these unique Screws save in making and assembling your product? It costs nothing to find out. Attach to the coupon a description of one or more of your fastening jobs, and our Assembly Engineers will report whether these Screws can be used to advantage.

Type "Z" Hardened Self-tapping Sheet Metal Screws

For joining and making fastenings to molded, cast and laminated plastics; die castings and sheet metal. Just turn Screw into drilled or molded hole. Can be removed and replaced without impairing holding power.

Type "U" Hardened Metallic Drive Screws

This type of Self-tapping Screw is for making permanent fastenings to molded, cast and laminated plastics, also steel and metal castings. Just hammer the Screw into a molded or drilled hole and you have a secure fastening.

PARKER-KALON *Hardened* Self-tapping Screws

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← 14 Unbiased Reports on Savings----------Scientists Explain Fastening Security →

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Tell us whether Self-tapping Screws can be used to advantage for assemblies described on attached sheet. Also send booklets on the Security and Economy of assemblies made with Self-tapping Screws.

Name and Company----------

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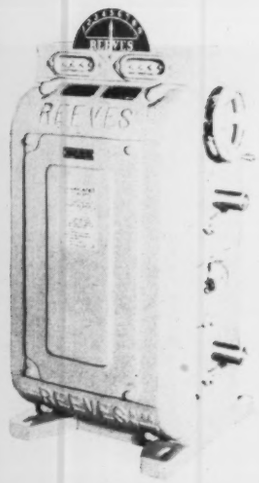
NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

Introduces Vertical Transmission

VERTICAL enclosed design variable speed transmissions which incorporate the standard internal operating units and possess all the utility of the horizontal design are a recent development of Reeves Pulley Co., Columbus, Ind. The vertical unit, shown herewith, is better adapted for certain standard equipment installations, and for installations requiring less floor space for the speed control unit.

An outstanding feature of the new model is convenience in lubrication facilities. Complete lubrication is possible without removal of the cover section. All radial, shaft and thrust bearings are lubricated through force feed fittings located in exterior panels, while shafts, driving keys and disk hubs are lubricated by means of force feed fittings in each end of the shaft extensions. From these fittings rigid copper tubes lead to the four radial shaft bearings, and flexible copper tubes to the four thrust bearings.



Vertical design of variable speed transmission may be equipped with electric remote, electric automatic or mechanical automatic controls

The vertical design may be equipped with electric remote, electric automatic and mechanical automatic controls, and with motors, motor bases and other accessories for varying requirements of speed control. The motor base is adjustable in order that any stretch in chain or multiple V-belt drive may be taken up. For extreme reduction in speeds, an auxiliary countershaft may be installed. This design is available in ten sizes, covering speed ratios of from 2:1 to 8:1 inclusive.

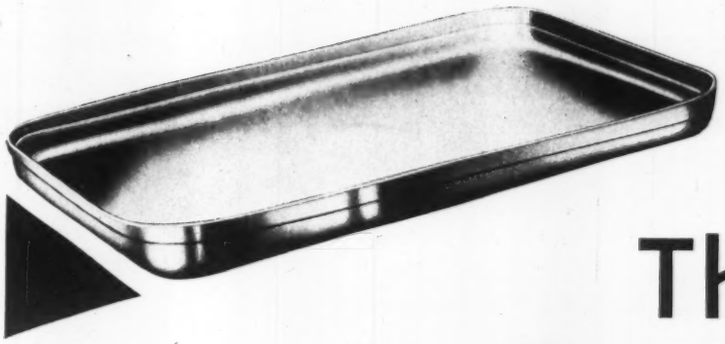
Oil Seal Has Few Parts

CONSISTING of only four parts, the oil seal developed by Aetna Ball Bearing Mfg. Co., Chicago, is a self-contained and complete unit which can be slipped in or out of position easily with nothing to work loose or become lost. The seal, shown herewith, has an outer shell of steel accurately formed and ground on an outside diameter to a precision commensurate with that of antifriction bearings. This shell houses the seal cushion, pressure plate and seal retainer.

Nonhygroscopic and impervious seal cushion of great resilience provides efficient operation with new oil seal

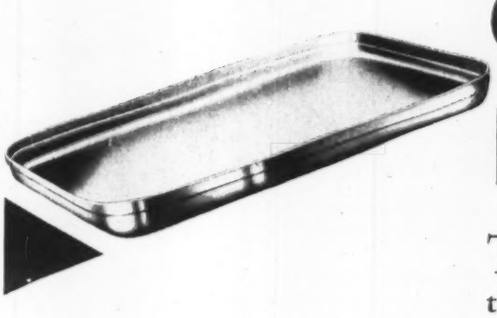
The thermo-pneumatic seal cushion consists of specially treated cork in which the interstices or air cells are captivated and hermetically sealed. This seal cushion is nonhygroscopic and impervious, is of great resiliency, has a low friction coefficient and is abrasive resistant. The deflector pressure plate, of dense, specially treated fiber, deflects oil from the seal proper, serving to maintain a constant and steady pressure upon the pneumatic cushion and a uniform pressure over the entire periphery of the seal while relieving it of extraneous internal pressure. In this way the pneumatic seal is maintained concentric with the shaft and is relieved of longitudinal pressure.

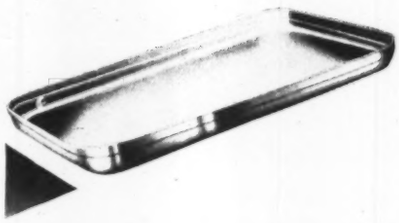
The new oil seal requires no pretreatment or

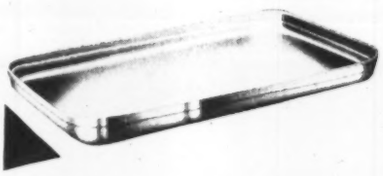


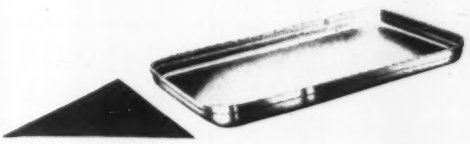
Stainless Steel

This stainless steel sink bottom makes it possible to attach body with seam about an inch above bottom surface so that dirt cannot accumulate in seam. This stainless steel used plus the design add to the cleanliness and sales appeal.









There IS One Way to Help Profits Now

THERE never were more than two ways to increase profits—increase income, cut costs. One way—the surest way—is just as easy as it ever was—if you take a logical road.

More and more are taking the road which leads through G. P. & F. Stamping Service.

If you do not use stampings now, perhaps G. P. & F. designers can point the way around the obstacle which seems insurmountable. Not only will you eliminate more costly materials and costly work, but you may increase the sales appeal of your product—lighter weight, beauty of design and finish. Perhaps you may even be able to increase price per unit after making these improvements—increase profits both ways.

If you already use metal stampings, G. P. & F. may still save you money. A half century of experience has taught G. P. & F. many cost-reducing short cuts.

It costs nothing to find out what G. P. & F. can do for your profits. Send a sample or blueprint, or write for booklet shown below.

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A-6801

special precautions such as soaking in oil, etc. Because of its design it is very thin. The seal, which may be used without trouble in installations where oil is on one side and water under pressure on the other, is available in sizes from ½-inch inside diameter and up.

Motors Require Low Starting Current

A PERMANENTLY short-circuited squirrel cage winding included as an addition to a wire winding is the outstanding feature of the new type RG repulsion-induction motors manufactured by Wagner Electric Corp., St. Louis. These motors, shown herewith, have a smooth speed-torque curve, without abrupt fluctuations, throughout the entire operating range—well adapted for severe starting duty.

Low starting current, close speed regulation, positive operation on low voltage and high power factor are available with these motors. There

Positive operation on low voltage and high power factor is available

is no internal short circuiting, and no brush lifting mechanism. The commutator carries part of the full-load current; the remainder is carried by the permanently short-circuited winding.

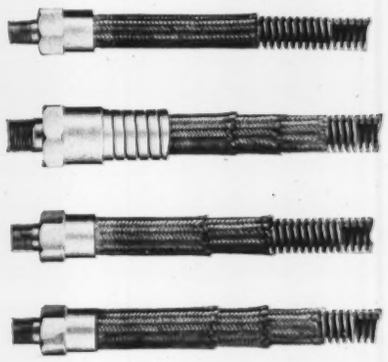
The flat brush springs are designed and formed to have safe fiber stress, assuring constant brush pressure, while brush holders of cast aluminum hold the brushes in place. Blowers of generous proportions assure positive, thorough ventilation of the motor essential for uniform distribution of heat.

Offers Seamless Flexible Tubing

SEAMLESS, flexible metallic tubing for use in fluid connections between moving parts absorption of vibration, and conveyance of liquids, semiliquids, steam or gas has been placed on the market by Bendix Aviation Corp. Machinery installations can be simplified by eliminating clumsy bends in piping while maintenance and replacement is reduced to a minimum.

The hose, shown herewith, is seamless from the tip of one fitting to the tip of the fitting at the opposite end because the fittings are brazed or welded on, forming an integral part of the hose. This construction prevents leaks developing in the hose and breaks occurring between the hose and its fittings. Made of special bronze alloy seamless pipe, the hose does not contain welded, brazed or interlocked joints.

A protective casing braided from copper is



Seamless from tip to tip of fitting, new flexible metallic tubing finds application in fluid connections between moving parts, and in similar operations

designed to cover the hose with either one, two or three layers, depending on the pressure the hose must withstand. As a protection against mechanical damage to the braid covering and to distribute the flexing action, the manufacturer recommends use of an interlocked, unpacked galvanized steel casing over all.

The hose is being manufactured with internal diameters of 3/16, ¼, ⅜, ½, ¾ and 1 inch Bendix Stromberg Carburetor Co., Tubing division, 608 West Fifty-seventh street, New York, has charge of the marketing.

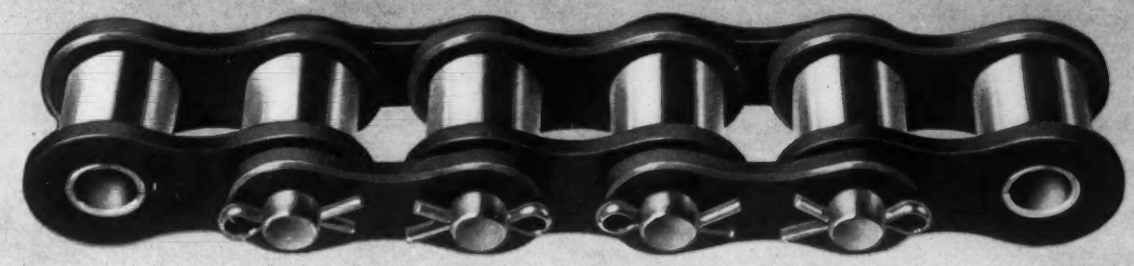
Announces Steel for Nitriding

AN UNUSUAL combination of properties for nitriding purposes is obtainable with a new steel containing chromium and vanadium that has been developed by Union Carbide & Carbon Research laboratories. This steel has many of the physical properties found in the SAE 6100 series. It contains from 0.50 to 2.50 per cent chromium, from 0.30 to 2.00 per cent vanadium, and from a very low percentage up to 0.70 per cent carbon, depending upon the physical characteristics desired. This new nitriding steel has just been announced by Electro Metallurgical Co., 30 East Forty-second street, New York.

The steel has high strength, ductility and resistance to shock. Ammonia nitriding is recommended as giving the best results where a heavy case is required, and a duplex cyanide treatment

CHAIN BELT COMPANY

REX ROLLER CHAIN



Its Qualities

Specially selected steels—accurately cut and machined—carefully casehardened—assembled by most modern machinery into a roller chain of outstanding qualities—high tensile strength, a high degree of finish and uniformity—handsome in appearance and completely interchangeable with other standard makes.

Rex Roller Chain is backed by the Chain Engineering Force of the Chain Belt Company with a complete line of malleable, steel and roller chain at their disposal and long skilled in the application of chain drives that fit the problem of the purchaser. Get in touch with the nearest Chain Belt branch office or return the coupon below for the catalog on Rex Roller Chains.

If you are unacquainted with Rex Chains, or are interested in this important new line of Rex Roller Chains, may we suggest that a line to the Chain Belt Company will bring you the complete new catalog of Rex Roller Chains containing in more than a hundred pages complete description of the chains and valuable data as to their possibilities and uses.

Use the coupon below

CHAIN BELT COMPANY, 1604 West Bruce Street, Milwaukee, Wisconsin

Please send the catalog on Rex Roller Chain to:

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REX ROLLER CHAIN

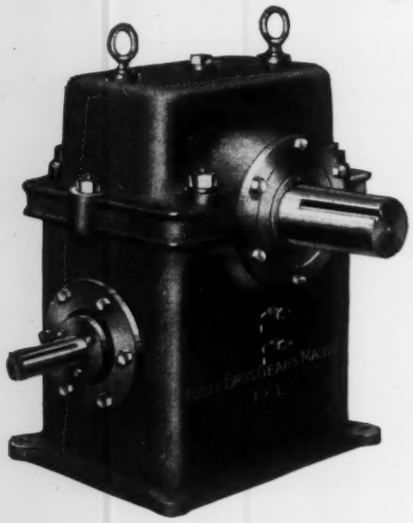
Established 1891—Branch Offices in 17 Cities

is entirely satisfactory if a thin, but extremely hard, case is desired. Nitriding can be carried out at comparatively low temperatures.

Thorough investigation has shown that the presence of vanadium in an unbound form, that is, not combined as a carbide, is important in securing surface hardening with nitrogen. About 0.30 per cent vanadium in excess of that required for the vanadium carbide is necessary, so that as the carbon content is varied, the vanadium content must be changed accordingly.

New Speed Reducer Is Introduced

WORM and worm gear of the size 5-HG added to the series of worm gear speed reducers built by Foote Bros. Gear & Machine Co., 215 North Curtis street, Chicago, are mounted in a substantial, oil tight, cast iron housing which provides a rigid support for bearings. The unit, shown herewith, is designed to transmit up to 14 horsepower continuous duty, this capacity depending on driving shaft speed and reduction ratio.



All shafts in new size worm gear speed reducer are heat treated alloy steel mounted on antifriction bearings

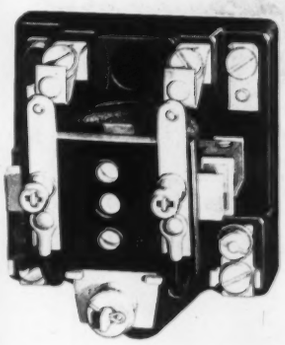
All shafts are heat treated alloy steel mounted on oversize antifriction bearings, usually thrust and radial ball bearings on worm shaft and tapered roller bearings on worm gear shaft Bearings permit hung load of 1750 pounds on the slow speed shaft of the vertical type of the 5-HG size. Maximum chain pull of slow speed shaft is 1375 pounds. Lubrication is accomplished effectively by splash system. Oil circulation is obtained through the action of worm and gear with the case so designed that oil is supplied automatically to all bearings.

The new unit fills a gap between sizes 4-HG and 6-HG and is for installations which could not be met economically with either of the last mentioned units. Size 5-HG will be built in five types—having worm at bottom; with worm on top; with worm gear shaft vertical; consisting of worm reducer with helical attachment; and having double worm and worm gear reduction. A wide range of ratios is available, varying from 3.5:1 to 3000:1.

Develops Small Magnetic Contactors

TO MEET an increasing demand for a dependable magnetic contactor of small ampere capacity, the Industrial Controller division, Square D Co., 710 South Third street, Milwaukee, offers two new sizes of class 8511 contactors designated types H and K, rating from 3 to 15 amperes for noninductive load or the fractional horsepower ratings for 110 volt single phase motors.

All desirable structural features of larger contactors are embodied in the design: laminated magnet frames, floating armatures to insure quiet operation, silver to silver contacts, porcelain bases, approved temperature and insulation standards, voltages up to 220 volts for Type H and 440 volts for Type K.



Small magnetic contactors embody all desirable features of large models

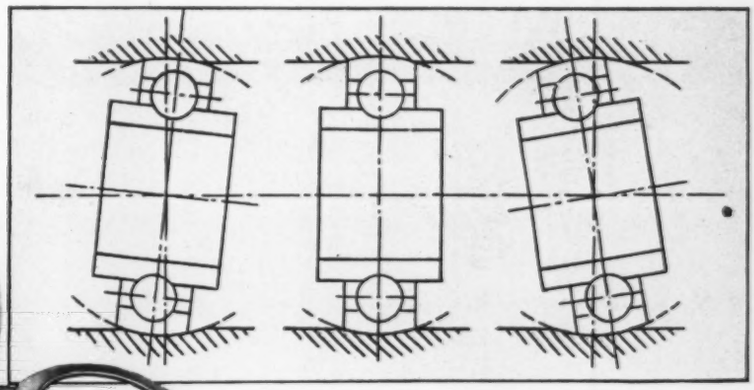
These contactors shown herewith are built in a variety of combinations: single and double pole, single and double throw, circuit opening and closing, two or three wire control, and three wire thermostat control.

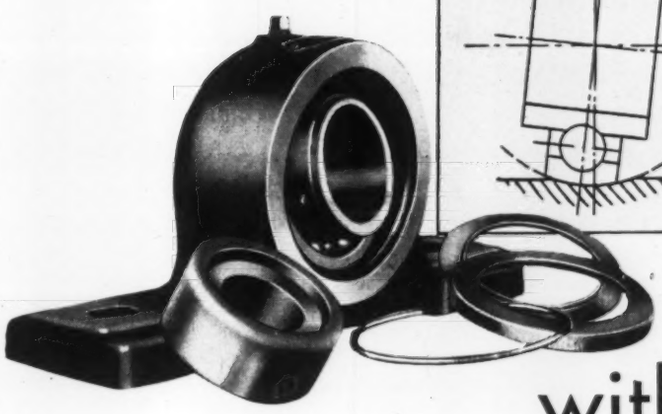
Applications include temperature regulators, oil burners, stokers, electric ranges, clocks, signal and lighting systems, and small motors.

Motor-Driven Reducers Are Compact

A SIMPLE, compact and efficient arrangement for powering various motor-driven equipment which operates at reduced motor speeds is afforded by new unit drives now available from Westinghouse Electric & Mfg. Co., Nuttall Works, Pittsburg. These new drives, known as Gearmotors, consist of speed reducers

Automatically aligning





Spherical seat leaves bearing free to compensate for shaft misalignment without sacrifice of race depth.

...without sacrifice of deep-race capacity!

Where crushing loads tug and shove and batter all day long, shafts are likely to misalign. Then the bearings must square themselves with the shaft, if they're not to cramp and wear. Only deep-race, **self-aligning** ball bearings make full provision for shaft deflection—without loss of bearing capacity.

Fafnir Power Transmission Units compensate shaft misalignment instantly...automatically...exactly! The bearing aligns **as a unit** in the housing...always stays square with the shaft. Shaft misalignment is accommodated outside the bearing, not in it. Not a bit of capacity is lost to gain this advantage... not a fraction of an inch of race depth or ball diameter!

Remove the costly consequences of shaft misalignment! Fortify your machinery with Fafnir Self-Aligning Power Transmission Equipment.

THE FAFNIR BEARING CO., NEW BRITAIN, CONN.

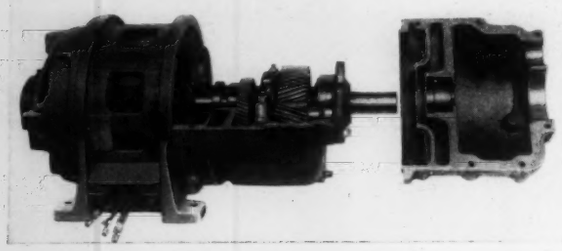
Atlanta Chicago Cincinnati Cleveland Dallas Detroit
Los Angeles Milwaukee Newark New York Philadelphia

FAFNIR
BALL BEARINGS

THE MOST COMPLETE LINE OF BALL BEARINGS IN AMERICA

combined with motors forming self-contained units only a few inches longer overall than motors alone. Each unit shown herewith, includes a general purpose induction motor and a double reduction nonplanetary type helical gear speed reducer built onto the one-piece motor frame.

The desired reduction of motor speed is obtained smoothly and quietly by helical gears and



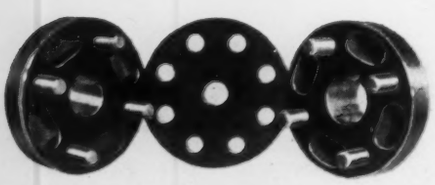
Reduction units combined with motors into one unit provide efficient drive

pinions the teeth of which are cut to a high degree of accuracy by the hobbing process. By a simple splash system of lubrication, all moving parts of the mechanism and one motor bearing receive oil continuously during operation. The other motor bearing is packed with grease. Seals on all shafts prevent oil escapement into the motor windings and to the outside of the unit at shaft apertures.

Gearmotors are built in sizes of ¼ to 15 horsepower with a wide selection of output ranging from 69 to 1550 revolutions per minute. A change in the output of any unit speed can be made readily.

Coupling Is Shock Resisting

IMPROVED flexible couplings which, in addition to compensating for parallel and angular misalignment, or combinations of both, embody a shock resisting feature and method of eliminating vibration are being manufactured by



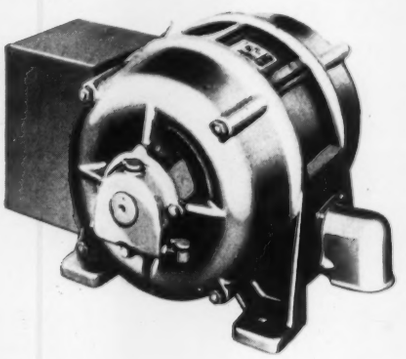
Couplings embody unique method of eliminating vibration

F. A. B. Mfg. Co., Sixty-seventh and Valejo streets, Oakland, Calif. The coupling, shown herewith, is said to overcome faults previously associated with drives of this kind. No lubrication is required and it is claimed that the improved coupling will operate noiselessly at 3450 revolutions per minute. The coupling is being manufactured in sizes up to 1200 horsepower.

Motors Have High Power Factor

CONDENSER reactive current flows through the windings of the motor thereby producing a high power factor within the mechanism in new capacitor-type polyphase induction motors being manufactured by Ideal Electric & Mfg. Co., Mansfield, O. This system gives these motors, shown herewith, improved running and starting characteristics. They operate at practically unity power factor at all loads.

The motors, designed by C. W. Noel of the Ideal company, are manufactured in models giving 80 per cent power factor leading at full load



Improved running and starting characteristics are available with new motor

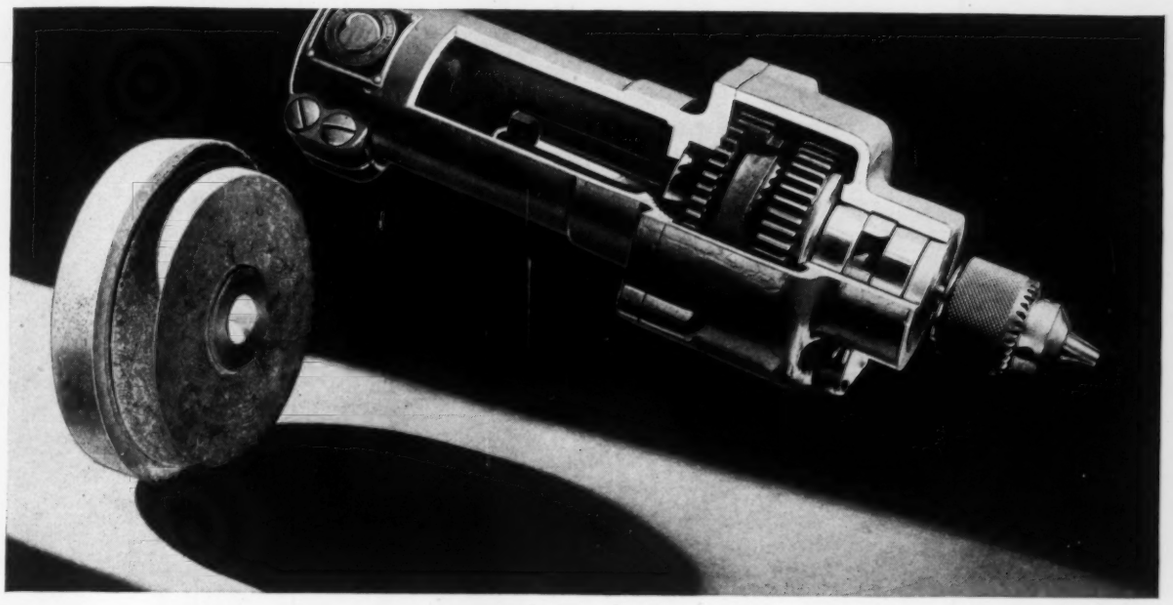
and leading power factors up to 15 per cent at no load. The capacitors used are the oil filled, oil impregnated, hermetically sealed type with individually fused sections. They are assembled in steel cases with conduit connections for mounting on the wall or any convenient location.

Capacitor motors also are made as slip ring variable motors in all sizes and speeds. This invention is particularly advantageous in a variable speed motor as this motor will retain its high power factor at low speeds, even to 50 per cent of standard rated speed. The new motor is built in models to meet all starting and inrush classifications including across-the-line starting in all sizes and speeds up to 200 horsepower at 80 per cent leading or unity power factor.

Motors Are Governed Accurately

ACCURACY approaching clock time and rapid acceleration are features of the new line of series wound motors with improved electric governors now being offered by Bodine Electric

Just The Material They Needed



TEXTOLITE molded is used as a double-cone friction clutch in the No. 2 Ball-bearing Tapping Attachment manufactured by the Leland-Gifford Company of Worcester, Mass.

Textolite molded was just the material they needed. Because it possesses a surface which allows smooth, positive engagement without harsh "grabbing," it more than tripled the life of the clutch — resulted in a smoother running machine — and all at a lower cost.

This illustrates just one case where Textolite molded has been adopted with marked success.

Possibly you have a part that also could be advantageously molded?

We shall be pleased to send you a copy of our bulletin, Plastic Products. Simply address General Electric Company, Plastics Department, Meriden, Conn.

***also* —**
Textolite laminated
Cetec cold-molded

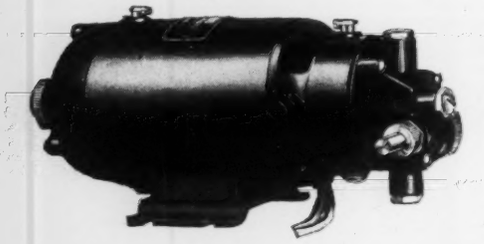
831-10

GENERAL ELECTRIC

PLASTICS DEPARTMENT, MERIDEN, CONNECTICUT

Co., Chicago. This new governor has shown itself reliable on such applications as talking motion picture equipment, electric pyrometer control drives, office appliances, traffic signal control, etc. Although most frequently applied to the series wound motor, this governor may also be used with the shaded-pole type motors.

The motors, shown herewith, are available in two forms: Form R, adjustable while running,

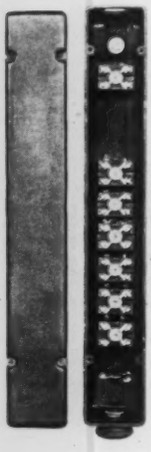


Electrical constants of motor governors are calculated carefully

and Form S, adjustable only at standstill. In the design of these motors, the electrical constants of the governor are calculated carefully to meet the requirements of the duty cycle and operating cycle of the load. The Bodine company is offering their laboratory facilities for testing these motors connected to manufacturer's apparatus.

Designs Pendant-Type Controls

DESIGNED primarily for the control of motors driving machine tools, a new line of pendant-type, momentary contact push button stations, designated Type CR-2940, has been announced by General Electric Co., Schenectady, N. Y. The stations, shown herewith, may be fitted with sufficient cable so that they readily can be carried around by the operator.



Pendant-type push button stations are protected against accidental contact

The unit provides both a normally open and normally closed circuit. The moveable contact is a silver plated disk normally held against the two top contacts by a spring. When the button is depressed, this circuit is broken and the circuit across the two bottom contacts is made. The units are mounted on the front of the case by means of screws, and are adaptable for mounting on the back of any cover plate or they may be built into a machine.

All of the buttons except the "stop" buttons are protected from accidental operation by means of a guard at the bottom of the button. The "stop" button is mounted on the bottom of the case and has a mushroom head which makes it easily accessible in case of emergency. A nameplate over each button clearly indicates its function. The case is provided with a conduit knockout of ample size at the bottom, and any standard BX fitting together with multiconductor cable can be used.

Switch Provides Safe Contacts

POSITIVE, safe and dependable contact between two pools of chemically pure mercury is provided by the new refractory protected mercury switch developed by Westinghouse Lamp Co., East Pittsburgh, Pa. To protect the glass walls of the switch, shown herewith, a refractory block is placed within the switch providing a chamber to confine the arc caused by the opening and closing of circuits having surge characteristics. The switch may be mounted and connected with ease and requires a comparatively small amount of energy in its operation. A few of its uses are temperature regulators, motor controls, sign flashers, lighting controls, time clocks, spraying equipment, and signals.

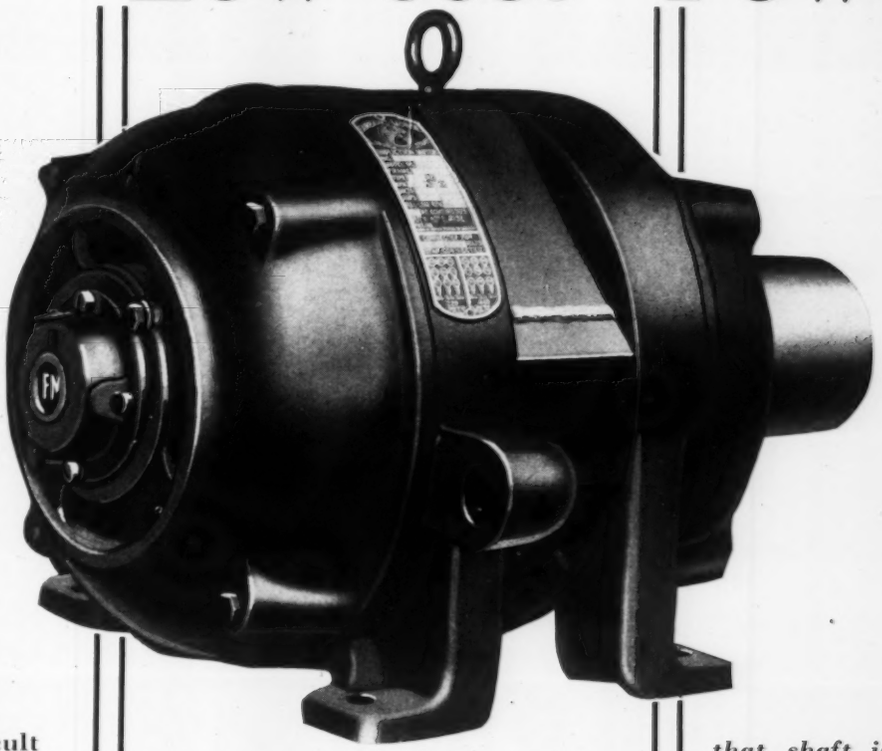
Refractory block is placed within the switch to protect the glass walls and provide safe and dependable contact

---

Push Buttons Are Explosion Proof

WATER tight and explosion proof push button control stations with levers for operation by finger, hand, foot, rope, or shipper rod have been developed by Allen-Bradley Co., 1311 South First street, Milwaukee. The stations, shown herewith, contain push button mecha-

S-T-A-M-I-N-A
Spells "Low-cost Power"



Fairbanks-Morse Type QLS (Line Start) Ball Bearing Motor

Standing up on difficult drives — stamina! That's what counts in a motor. That's what keeps power costs at a minimum — keeps production moving.

Stamina is built into Fairbanks-Morse Motors. No wonder they stand up when the going is tough. No wonder they give years of trouble-free service. Inspect one of these motors. Notice the heavy, broad feet that anchor it firmly to its job and keep it from "weaving." Look at the sturdy, rigid construction and end bonnets that fully protect the interior elements.

You'll find the same sound construction throughout. A short, thick shaft that takes any torsional strain without deflecting. *Note particularly how that shaft is hung on ball bearings!* This is one of the big reasons for F-M Motor super-performance. These bearings are sealed dust-tight. They require greasing but once a year! The insulation on F-M Motors is impervious to oil and moisture—will not harden or crack under adverse operating conditions.

Let us send complete information about Fairbanks-Morse Motors. Go over F-M construction point by point. See how F-M "Built-in" stamina will help you to keep power costs low. There's no obligation.

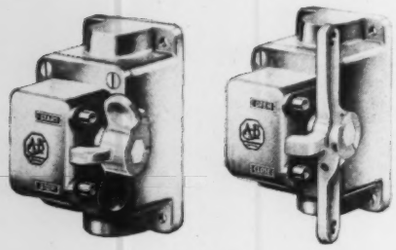
FAIRBANKS, MORSE & CO.
900 S. Wabash Ave., Chicago
32 branches at your service throughout the United States

FAIRBANKS-MORSE
MOTORS

5200—EA40.36

nisms for either standard duty or heavy duty service, enclosed by a cast iron box with cover, all cadmium plated, and tapped for ¾-inch conduit. The watertight stations are provided with rubber gaskets, which also exclude gases. The cover and box of explosion proof stations are machined to provide an explosion proof seal without gaskets.

The watertight stations find use in dairies,

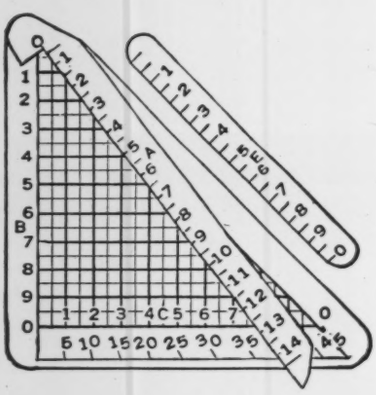


Explosion proof push button control stations have levers for operation by finger, hand, foot, rope or shipper rod.

laundries, dye plants, outdoor installations, etc., where precautions must be taken to exclude liquid and moisture to insure reliability of the control apparatus and safety for the operator. Explosion proof control stations are extensively used in chemical plants and other installations where inflammable gases are likely to be present. These stations may be provided with a single button for 2-wire pilot control or with two buttons for 3-wire pilot control.

Tables Aid in Involved Calculations

IMPROVED calculator and trigonometric function tables have been devised by J. S. Ronay, Box 254, Cleveland, to provide a simple means of making involved calculations. A feature of the new calculator, shown herewith, is its accuracy obtained by using a special precision graduation machine in its reproduction.



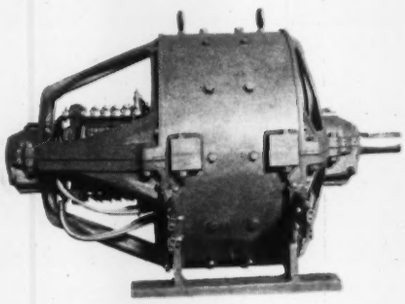
Improved calculator aids in solving involved mathematical problems

The base of the device is a 45-degree right triangle which is divided in both directions into 10 equal parts and subdivided decimally. At the apex of this base triangle is pivoted a movable hypotenuse which has decimal unit scales identical with the base. With the device it is possible to read by a single setting all functions of an angle. Multiplication, division, proportions, structural graphic stresses and other applied mechanics problems may be performed on it.

Introduces Larger Motors

LARGER motors for its type T direct current line have been announced by Reliance Electric & Engineering Co., 1088 Ivanhoe road, Cleveland. The new motors range in size from 100 horsepower at 800 revolutions per minute to 350 horsepower at 1200 revolutions per minute and can be supplied for constant speed or adjustable speed service with a range of 2 to 1 or 3 to 1.

A rolled steel split frame construction is used for the motors, shown herewith. Two oil rings at the front end, and three at the back keep the bearings well lubricated. The brushholders combine the advantages of the reaction type with those of the box type. Brushes are always kept at proper tensions. Hard drawn copper bars are used for the commutator. The construction of the commutator is such that the bars will not loosen upon expansion and contraction.



Larger motors are introduced for direct current line

Automatic Starters Are Oil Immersed

EXPLOSION proof alternating current automatic starters manufactured by the Industrial Controller Division, Square D Co., Milwaukee, have been approved by the Underwriters' Laboratory for use in Class 1, Group D, hazardous locations. The starters, shown herewith. known as class 8528, are of the oil immersed type and control across-the-line single and polyphase motors.

The starter consists of a cast iron head, welded steel tank and starter panel. The head casting,

AETNA Oil Seal

AT LAST . . . an oil seal that actually holds oil! And, of course, grease, water and liquids. And it "stays put."

You can apply the Aetna Oil Seal to oscillating and revolving, vertical and horizontal shafts operating at the highest or lowest speeds or stationary, and know it will stay oil-tight many times longer than any other type of seal.

Major reasons are: The thermo-pneumatic cushion; and the deflecting plate, which relieves the seal proper of longitudinal pressure. Its design is as radically different as its performance is a revolutionary improvement.

The Aetna Oil Seal has introduced a new basis of performance—and comparison. Ask how!

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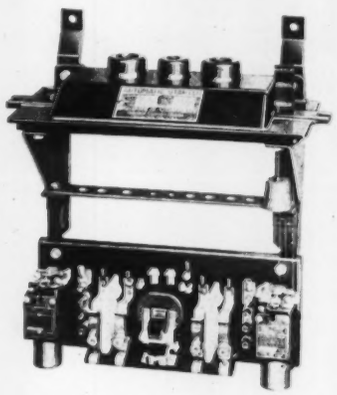
BUSHING BEARINGS

which is provided with brackets for wall mounting, supports the steel angle frame to which the starter panel is secured, and the oil tank. The panel consists of a three-pole magnetic contactor and two oil dashpot overload relays. A visible gage indicates the maximum, normal and minimum oil level in the tank. The oil in which



Alternating current starters may be used in hazardous locations without danger of an explosion

the terminals and electrical parts are immersed will prevent an arc passing to the surrounding fumes and gases. A special arrangement prevents the deterioration of incoming leads and capillary action.

Applications are found in equipment for gasoline refineries and filling stations, dry cleaning plants, paint, varnish, lacquer plants, etc. Ratings include 5 to 50 horsepower at 220 volts; 7½ to 75 horsepower at 440 and 550 volts polyphase.

Publish Gear Load Treatise

THE influence of errors in tooth profiles, and the influence of pitch-line velocities is covered extensively in a 72-page treatise, entitled "Dynamic Loads on Gear Teeth," by Prof. Earle Buckingham, recently issued by the American Society of Mechanical Engineers. The book is based on the past five years' experimental work which Professor Buckingham has been conducting at the Massachusetts Institute of Technology for the mechanical engineers' special research committee on strength of gear teeth. Initiation and continuation of this work were due largely to efforts of the late Wilfred Lewis. Copies of this publication may be obtained at 29 West Thirty-ninth street, New York, for $1.75.

FRICTIONAL loads on a 4-mill cotton gin of the Villa Rica Mills Inc., were reduced appreciably by the installation of self-aligning ball bearings, according to a recent Neilson survey. The survey lists other advantages of this type of equipment such as exclusion of dirt from bearings, more nearly perfect lubrication, no misalignment of shafting, and reducing belt repairs.

Billet from which the "shape" is extruded at our mill
Die through which we extrude the "shape" in long lengths
Extruded Shape (Hinge Section)
Sawed to length by you
Milled, Drilled and Countersunk by you
Completely Machined, ready for Polishing and Assembling by you

Here are shown the progressive steps whereby a Revere special Extruded Shape readily becomes a hinge plate. Plastic Machining offers similar opportunities to manufacturers of a wide variety of metal products.

Plastic Machining

speeds your production and lowers your costs

Plastic machining means less machining for you. It is, in effect, pre-machining by us while we have the metal hot. When you buy Revere Forgings or Extruded Shapes, you receive metal that is well on its way to becoming your finished part or product.

A Revere "twice-wrought" Brass Forging with but little finishing becomes a valve bonnet—a Revere Extruded Angle, a controller contactor—a Revere Special Extruded Shape, a door hinge. By the use of these twice-wrought Revere Products, you gain the further advantages of uniformity, density, strength, freedom from defects, no rejects, a minimum amount of scrap.

With the uniformity of size and the smoothness of surface obtained in a Revere Forging, rapid handling and accurate work in jigs and fixtures are insured; also, automatic or semi-automatic machine feeding becomes possible.

With special holders or chucks, Revere Extruded Shapes may be fed into turret lathes or screw machines in long lengths, where they may be turned or drilled as readily as concentric rods. Or they may be sawed into short lengths and hot or cold forged with great economy in press operations and with a very material saving in the amount of flash, which is waste.

With your own ingenuity and the aid of our technical staff in studying your problem, we confidently believe the use of Revere Plastic Machining will speed up your production, reduce your overhead, and lower your costs.

Why not start our cooperation with you by writing Revere Copper and Brass Incorporated, 230 Park Avenue, New York City?

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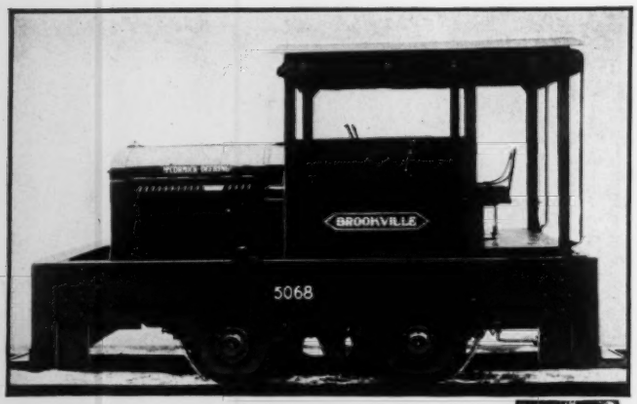

BALDWIN CHAIN *and*
SPROCKETS CHOSEN
for TRACK HAULAGE

The dependability, strength and wearing qualities of Baldwin Alloy Steel Roller Chains and Baldwin Accurate Cut Sprockets are contributing to the success of the rugged gasoline locomotives manufactured by the Brookville Locomotive Company, Brookville, Penna.

Whenever maximum average breaking strength is required, as in heavy track haulage work, Baldwin Chains are performing in a way that brings mutual satisfaction to the user and manufacturer of equipment.

•

Baldwin Engineering Service is yours for the asking. Bulletins 40 and 42 will introduce you to Baldwin.

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BALDWIN-DUCKWORTH CHAIN CORPORATION

Baldwin Division, Worcester, Mass.

Duckworth Division, Springfield, Mass.

BALDWIN
DUCKWORTH

MEN OF MACHINES

(*Concluded from Page* 52)

Engineers, held last June at the University of Wisconsin.

* * *

E. W. Templin has been made chief engineer of the Curtis Mfg. Co., Los Angeles.

* * *

W. S. Pritchard, formerly factory manager, Detroit Aircraft Corp., has been appointed development engineer with Doehler Die Casting Co., Toledo, O.

* * *

R. M. Bickley has been appointed chief engineer of Heyl & Patterson Inc., Pittsburgh, builder of material handling machinery, succeeding L. J. Robb. Mr. Bickley recently was assistant chief engineer.

* * *

Alfred E. Waller, formerly chief engineer of the Ward Leonard Co., and managing director of the National Electrical Manufacturers association has joined the Clark Controller company's organization, and will make his headquarters at the Sundh Electric company's plant in Newark, N. J.

* * *

Mead F. Moore, who was in charge of the engineering division of the Milwaukee plant of the Nash Motors Co., Kenosha, Wis., from its establishment in 1922 until it was consolidated with the main works in Kenosha, has been appointed chief engineer of the Nash works in Racine, Wis. He succeeds N. E. Wahlberg, who recently was elected vice president in charge of all engineering for the Nash company.

* * *

Harold W. Bibber left the central station engineering department of the General Electric company on January 1 to become associate professor of electrical engineering at Ohio State university. Educated at Massachusetts Institute of Technology and the Ecole Superieure d'Electricite in Paris, he spent the years 1920-21 in France representing Massachusetts Institute of Technology as an exchange instructor to the Ecole Centrale des Arts et Manufactures, Paris. On his return he was an instructor in electrical engineering at Massachusetts Institute of Technology for two years, after which he joined the staff of the International General Electric Co., at Schenectady.

UNDERWRITERS' LABORATORIES INSP. CORD A-5

This Label

identifies the quality of Belden Lamp and Heater Cords

This is not an advertisement for a new or different wire.

For a long time Belden Underwriters' approved lamp and heater cords have commanded wide recognition in the electrical industry for their quality and safety.

Now the new "Five-foot" Underwriters' Approval Label provides a new and powerful merchandising advantage on all appliances equipped with approved cord, because the consumer at the point of sale has unassailable evidence of the safety and quality of the wire.

Millions of Belden cords, plain and equipped with the Belden Unbreakable Soft Rubber Plug, are furnished annually to manufacturers of America's leading electrical appliances. Write or wire today for prices on your approved cord requirements.

Belden Manufacturing Company
4639 West Van Buren Street, Chicago

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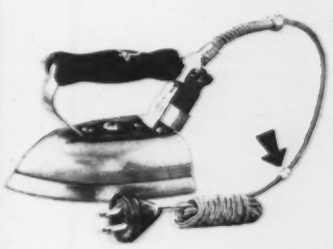
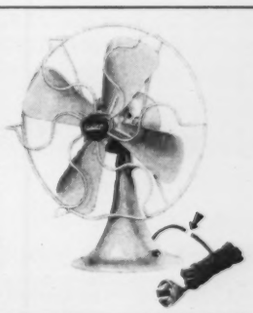
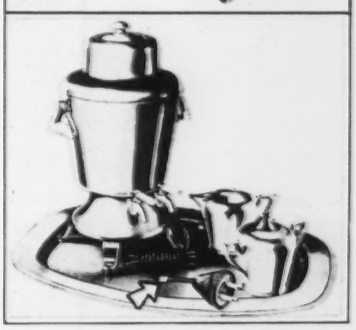
Belden Products

Beldenamel and Textile Magnet Wire • Automotive Wires and Cables • Airplane Assemblies • Radio Wires, Cords and Cables • Rubber Covered Wires • Flexible Armature Wires • Armored Cables • Motor Lead Wires • Braided and Stranded Copper Cables • Cotton Sleeving

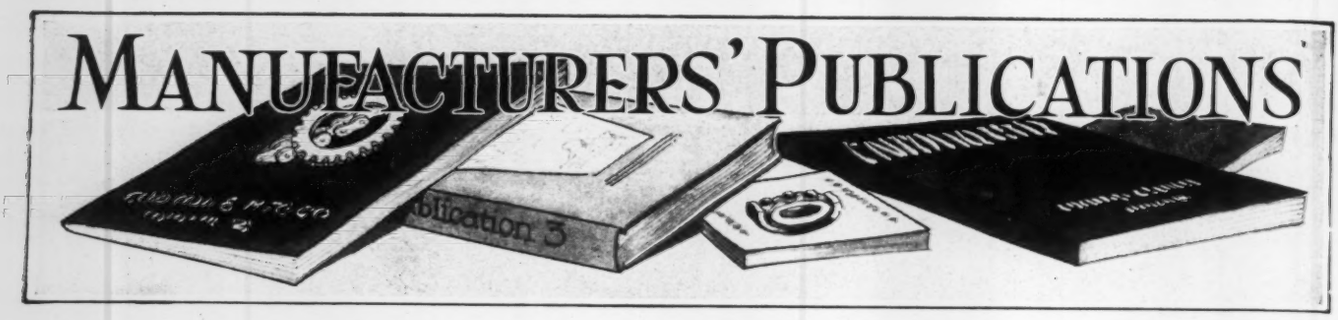
The Belden Unbreakable Soft Rubber Plug is another means of identifying approved lamp and heater cord. The plug is nationally advertised and recognized by millions of consumers as a mark of superior quality on appliances. All lamp and heater cords equipped with this plug are approved by the Underwriters.







MANUFACTURERS' PUBLICATIONS



Publications listed in this section may be obtained by engineers responsible for design from the manufacturers of the products or through MACHINE DESIGN

ALLOYS (ALUMINUM)—Aluminum Co. of America, Pittsburgh, has issued a well-prepared book on "Alcoa Aluminum and Its Alloys." This 64-page book gives in concise form information concerning the physical and chemical properties of aluminum alloys produced by the company. In addition it contains tables showing the sizes of the basic commodities manufactured from these alloys, commercial tolerances for various commodities, and 28 other tables containing engineering data.

ALLOYS (BRONZE)—Barry Bronze Bearing Co., Camden, N. J., has prepared a bulletin listing the various types of alloys which it manufacturers and indicating the uses and advantages of each.

ALLOYS (STEEL)—The properties and advantages of a new nitriding steel are discussed in detail in technical bulletin No. CV1, entitled "Chrome-Vanadium Nitriding Steel," which has just been released by Electro Metallurgical Co., New York. The steel, possessing many of the characteristics of the SAE 6100 series, offers an unusual combination of properties for nitriding purposes.

ALLOYS (STEEL) — American Stainless Steel Co., Pittsburgh, is offering an attractive booklet covering uses of the group of corrosive resistant steels manufactured by the company. The classifications include advantages of use of this steel in food handling equipment, automotive equipment, oil handling equipment, paper making machinery, textile mill machinery, and similar groupings.

DIE CASTINGS—A leaflet by Allied Die-Casting Corp., Long Island City, N. Y., contains a table of physical properties of various alloys and metals and a presentation of a variety of uses of die castings.

DRIVES—Gears & Forgings Inc., Cleveland, has published a comprehensive bulletin on its motorized speed reducers of the planetary type. Bulletin D includes the advantages of the planetary construction, specifications, description of the units, types of drives available and considerable engineering information.

DRIVES—Gearmotors, consisting of speed reducers compactly combined with induction motors into general purpose unit drives are the subject of a new publication, Leaflet 20536, issued by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Information on application and operation, details of construction, a listing of sizes and speeds, and dimensions are contained in the leaflet.

FINISHES—Aluminum Industries Inc., Cincinnati, has issued a folder describing its type of aluminum coating for finishing products.

FINISHES—Plating steel and other metals with tin by use of sodium Stannate-acetate plating bath is described in a booklet issued by Roessler & Hawslacher Chemical Co., Niagara Falls, N. Y. The publication contains information on the composition and preparation of the solution, operating conditions, methods of control and maintenance, testing, and other data.

MOTORS—Large type T direct current motors, manufactured by Reliance Electric & Engineering Co., Cleveland, ranging in size from 100 horsepower, 200 revolutions per minute to 350 horsepower, 850 revolutions per minute are presented in bulletin No. 211 of the company. The bulletin includes details of construction, cross sectional drawings and table of ratings.

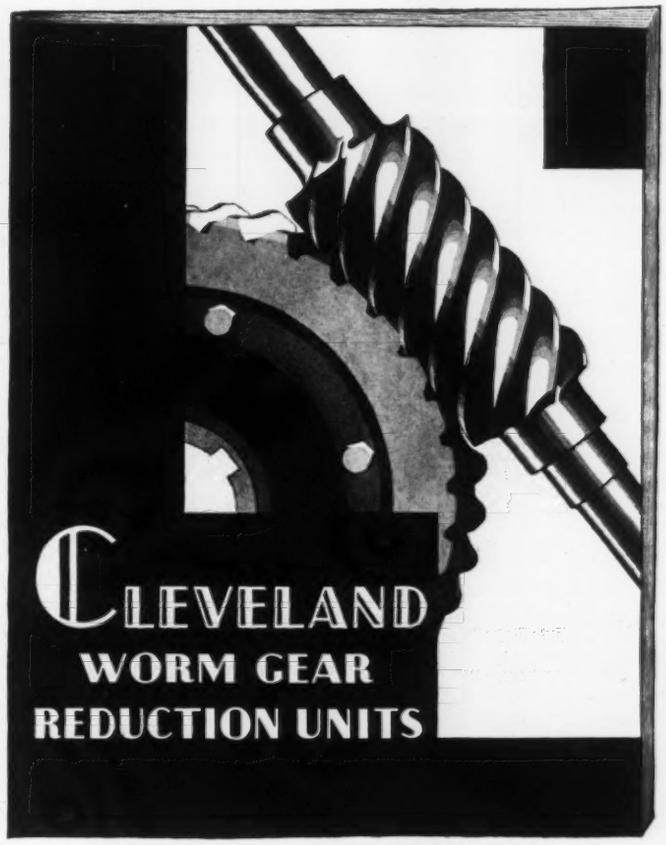
MOTORS—Wagner Electric Corp., St. Louis, has issued bulletin 173, part 4, on type RG brush-riding repulsion-induction motors. The motors comply with NEMA classification for this type, that is the rotor in addition to having a wire winding also has a permanently short circuited squirrel cage winding. Another recent publication of the company is bulletin 167, part 7, which covers polyphase squirrel cage motors. Operation, application, ratings and mechanical variations of these motors is given.

MOTORS—Constant speed motors for general purpose use on long hour duty are described in bulletin No. 1007-B of Bodine Electric Co., Chicago. The motors are rated 1/20 and 1/15 horsepower at 1725 revolutions per minute and 1/40 and 1/30 horsepower at 1125 revolutions per minute. Another new bulletin, No. 1014, presents alternating and direct current constant speed motors with built in worm gear speed reducers. These motors provide gear reductions of 10:1, 20:1 and 40:1.

HYDRAULIC EQUIPMENT—Suction-line primers with strainer and check valve compactly arranged in one casting are the subject of bulletin 530 of Barrett, Haentjens & Co., Hazleton, Pa. These primers are for manual and automatic operation of centrifugal pumps with suction lift.

TUBING—Flexible metallic tubing that is seamless from tip to tip of fittings (no welded, brazed, or interlocked joints) is presented in a recent pamphlet prepared by the Tubing division, Bendix Stromberg Carburetor Co., New York. The tubing can be furnished for pressures as high as 6000 pounds per square inch and for temperatures not exceeding 500 degrees Fahr. with single, double, or triple wire braid or with interlocked protective casing.

WELDED PARTS AND EQUIPMENT—Lincoln Electric Co., Cleveland, in application sheet No. 26, series 2, illustrates methods of welding for bearings.



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